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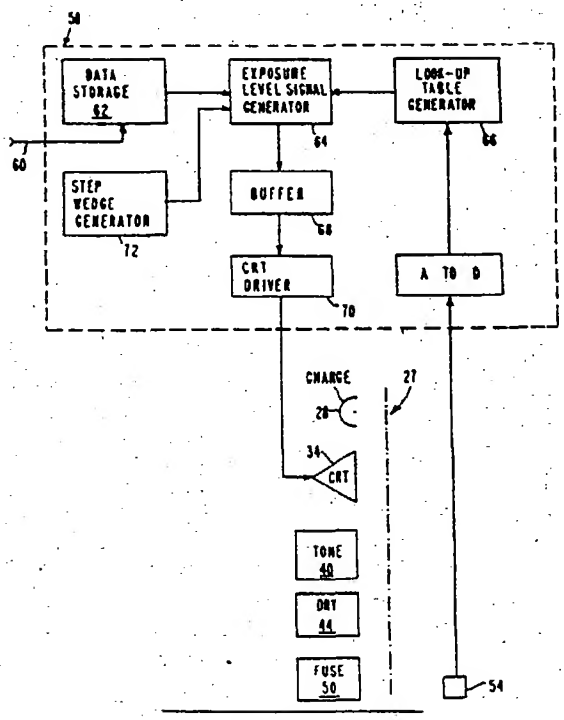
(54) Explosure control system for continuous tone elektrophotographic film.

(57) An exposure control system which permits accurate reproduction of optical density levels on a final image is characterized by a dynamically corrected look-up table. The look-up table is used to calculate each desired exposure intensity level for each image pixel on the basis of data obtained during the exposure and development of an immediately preceding image.

F I G. 2



EP 0 269 033 A2

EXPOSURE CONTROL SYSTEM FOR CONTINUOUS TONE ELECTROPHOTOGRAPHIC FILM

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention relates to electrophotography and more particularly to a method for controlling the intensity of exposure of an electrophotographic continuous tone film to accurately reproduce a desired optical density range.

DESCRIPTION OF THE PRIOR ART

Electrophotographic image reproduction systems have been in existence for a number of years. In general, such systems operate as follows. An imaging element comprising a photoconductive layer that upon exposure to actinic radiation becomes conductive allowing an accumulated charge on the element surface to selectively bleed through a conductive path is first charged with a uniform charge layer by passing such element under a source of ionizing radiation, e.g., a scorotron or other such corona charging device. The charged surface is then exposed to imagewise modulated actinic radiation, rendering the photoconductor layer conductive and discharging the accumulated charge. The term "actinic radiation" is construed to encompass not only photochemical activity but also the photoelectric effects described herein and the like.

In a continuous tone system, as contemplated herein, the amount of charge left on the imaging element surface is inversely proportional to the amount of actinic radiation received by the element. In this manner a pattern of electrostatic charges is produced on the imaging element forming a latent image corresponding to the imagewise modulated actinic radiation incident on the element. The magnitude of the electrostatic charge at any one point on the imaging element is inversely proportional to the intensity of the exposing actinic radiation.

The latent image may now be rendered visible by development using colored particles which preferably bear a static charge and which are attracted to the charge pattern on the imaging element. Depending on the desired result, the colored particles may bear a charge of the same polarity as the charge originally placed on the imaging element or an opposite polarity. If the charge polarities are the same and an appropriate bias electrode used the colored particles are preferentially attracted to the areas from which the original charge has been bled away, producing a "dark" or "colored" area of intensity proportional to the original exposure. If the charge polarities are opposite, then the areas that received the least exposure to actinic radiation will attract the most particles. In the first instance there is an image reversal; the light tones appear dark and the dark tones appear light. In the second instance the image tones are reproduced the same as the original.

The colored particles may be in dry form or may be supplied in a dispersion in a carrier liquid. Generally referred to as toners, the colored particles or dispersions are well known in the art. Liquid toners tend to produce higher image resolution and are sometimes preferred for that advantage.

Following toning, the image may be viewed as such, dried, fused or transferred onto a receiving element or any combination of the above, as is well known in the art.

In recent years the widespread use of computers and their ability to store and manipulate large amounts of data has resulted in image handling systems that employ image enhancement in applications such as radiography, printing, etc. In radiography, for instance, a radiogram may be split into a number of digitally encoded picture elements, or "pixels", transmitted through telephone lines, stored on a disk, retrieved at will, contrast enhanced, and displayed for diagnostic purposes. Typically display media are cathode ray tubes, silver halide film, electrostatic display, etc.

At present the display of high resolution diagnostic quality images is inadequate. Cathode ray tube displays have limited resolution and dynamic range. Reproduction on a silver halide film, while offering excellent resolution and dynamic range, is expensive, usually time consuming and requires darkroom facilities. Electrophotography is very promising since it reproduces high resolution images of sufficient dynamic range rapidly without the need for dark room development and complicated chemical processes. However, in order to obtain the required diagnostic quality in the finished product the exposure intensity level must be controlled to compensate for the electrostatic charge-retaining characteristic response of an

electrophotographic film and for the toner electrostatic response. To complicate matters neither the response of the film nor of the toner is linear, and both tend to vary with time, usage and/or environmental conditions.

Accordingly, in view of the foregoing, it is believed advantageous to provide a system for the accurate reproduction of the tonal range in a continuous tone image.

SUMMARY OF THE INVENTION

In accordance with of this invention there is provided an exposure control system which permits the accurate reproduction of desired optical density levels on a final image through the use of a dynamically corrected look-up table. The look-up table is used to calculate each desired exposure intensity level for each image pixel on the basis of data obtained during the exposure and development of an immediately preceding image. This is possible because changes in the characteristic response of both the film and the toner are gradual so that data developed during one exposure can be used successfully to control the following exposure.

It is in accordance with this invention to provide a method for generating a dynamically corrected look-up table for modulating the intensity of actinic radiation incident on an imaging element comprising the steps of:

(a) modulating the intensity of actinic radiation representative of an image having a predetermined number of variable optical density levels in accordance with a dynamically corrected look-up table.

(b) exposing an imaging element to the modulated actinic radiation representative of the image.

(c) modulating the intensity of the actinic radiation with information representative of a step wedge having a predetermined number of known optical density levels using the dynamically corrected look-up table.

(d) exposing the imaging element to the actinic radiation modulated by the step wedge information.

(e) developing the image and step wedge on the imaging element.

(f) comparing the optical density levels of the developed step wedge to the known optical density levels.

(g) generating a correction signal based on the difference between the developed step wedge optical density and the known optical density levels, and

(h) correcting the look-up table in accordance with the correction signal.

BRIEF DESCRIPTION OF THE DRAWINGS:

The invention will be more fully understood from the following detailed description thereof, taken in conjunction with the accompanying drawings, which form a part of this application and in which:

Figure 1 is a stylized pictorial representation of an apparatus useful in the practice of the present invention;

Figure 2 is a functional block diagram of the apparatus of Figure 1, useful in practicing the present invention;

Figure 3 is a graphic representation of the relationships between imaging element, toner, input and output optical density and exposure intensity for a system in accordance with the present invention; and

Figure 4 is a graphic representation of the relationship between the input and output optical densities and the exposure intensity for a system in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Throughout the following detailed description similar reference numerals refer to similar elements in all figures of the drawings.

With reference to Figure 1 shown is a stylized pictorial representation in perspective of an electrophotographic copying apparatus generally indicated by reference character 10 useful to implement the present invention. The apparatus 10 includes a drum 12 mounted for rotation in the direction of the arrow 14 about an axis of rotation 16. The drum has a surface 12S. The drum 12 is also provided with an array of conductive rollers of which three such rollers 18A, 18B and 18C are shown. The rollers 18 are connectible to a predetermined electrical potential, preferably ground. Means for holding a film sheet to the surface 12S

of the drum 12 is provided. Suitable for use as the holding means is a vacuum hold-down system including a vacuum pump 20 operatively connected in fluid communication with a plurality of holes 22 arranged in the surface 12S of the drum 12. It should be understood that any other suitable holding means may be used, such as, a properly placed clip arrangement.

A sheet film feeder 24 is disposed adjacent to the drum 12. The feeder 24 is adapted to dispense an electrophotographic imaging element 26, hereinafter referred to as the film sheet, onto the surface 12S of the drum 12. The film sheet 26 carries an imaging surface 26I thereon. The film sheet 26 is held in place by the holding means discussed above such that the imaging surface 26I faces outwardly away from the surface 12S of the drum 12 as the drum 12 transports the film sheet 26 along a path of transport 27 through the apparatus 10. The sheet 26 comprises two layers on a supporting base, usually seven mil polyester base. The outer of the two layers containing the imaging surface 26I is a photoconductive layer. The other layer is electrically conductive. A portion of the outer layer is removed along at least one edge thereof to define a strip of conductive layer so as to permit the conductive layer to be grounded through contact with the rollers 18A, 18B or 18C as the film sheet 26 is transported along the path of transport 27.

A scorotron or other corona-type charging device 28 is placed adjacent to the drum 12 downstream in the direction of rotation shown by the arrow 14 from the film feeder 24. The scorotron charging device 28 is operative to apply a uniform electrostatic charge over the entire imaging surface 26I of the film sheet 26.

An exposure station 32 is located adjacent to the drum 12 downstream in the direction of the arrow 14 from the charging device 28. The exposure station, which is a source of radiant energy in the form of modulated actinic radiation, preferably comprises a cathode ray tube (CRT) 34 having a fiber optic faceplate 36. The term "actinic radiation" is construed to encompass not only photochemical activity, but also the photoelectric effects described herein and the like. The faceplate 36 terminates in close proximity to the imaging surface 26I of the film sheet 26. A laser may be substituted as a source of actinic radiation.

Next following the exposure station 32 in the direction of the arrow 14 is a toning station 40. The toning station 40 is implemented in the preferred instance by a conventional liquid toner applicator of the type sold by Imagen Corporation as part number AG3-0054-020 milled to conform to the curvature of the drum 12. A D.C. motor is preferably substituted for the original A.C. drive motor and a passive roller is given an active drive. A drying station 44 typically comprising an air blower is located adjacent to the toning station 40.

A stripping means indicated by reference character 48 is placed in an operative position along the path 27 of the film sheet 26 to strip and to guide an exposed and imaged film sheet 26 from the surface 12S of the drum 12 to a fusing station 50. The stripping means 48 preferably takes the form of a vacuum release mechanism. The fusing station 50 typically comprises a pair of pressure rollers 52A, 52B. Depending upon the particular toner used at least one of the pair of rollers 52 may be heated to assist in the fusing of the toner.

An exposure measurement device 54 comprising a light source and associated photodetector is placed along the path of one edge of the film sheet 26. As is discussed herein the device 54 measures the optical density of a predetermined step wedge or tablet exposed along one edge of the surface 26I of the sheet 26. Wedges and step tablets are known in the art and discussed, e.g., in SPSE Handbook of Photographic Science and Engineering, Thomas Jr., Editor, Willey Interscience, 1973 edition, pages 783 and 784. A film sheet receiving tray 56 is provided to receive an imaged film sheet 26 exiting from the fusing station 50.

An electronic exposure control system 58, discussed in more detail herein, is provided to control the operative elements of the exposure apparatus 10.

The operation of the exposure apparatus 10 may be best understood in connection with Figures 1 and 2 in which the latter is a simplified functional block diagram of the main elements of the apparatus used in the generation of an image on the surface 26I of the film sheet 26 in accordance with the present invention.

In operation, upon command through an input line 60 a film sheet 26 is released from the feeder 24 onto the surface 12S of the rotating drum 12. The film sheet 26 is held on to the drum 12 by the action of the vacuum pump 20 through the holes 22. The film sheet 26 is then uniformly charged over its surface 26I by the action of the scorotron 28. The charged film sheet 26 is transported along the path of transport 27 past the exposure station 32 where it is imagewise exposed to actinic radiation of varying intensity. As a result of this imagewise exposure the surface 26I of the film sheet 26 is selectively discharged in proportion to the intensity of the incident radiant energy leaving on the surface 26I of the film sheet 26 a charge pattern of various intensities representative of a latent image.

The latent image is rendered visible by toning. Toning occurs in the toning station 40 where the surface is preferably immersed in a pool of liquid toner. Toner particles are attracted to the charged pattern on the surface 26I in proportion to the charge density on that surface. The surface 26I of the toned film sheet 26 is dried of any residual liquid at the drying station 44, stripped from the drum by the stripping means 4B, and the toner image is permanently fixed onto the surface 26I in fusing station 50.

As part of the exposure process a step wedge comprising an image of a predetermined number, usually fifteen, of predetermined intensity (gray) levels ranging in optical density from transparent to opaque is exposed onto the surface 26I of the film sheet 26. The step wedge is preferably disposed along one edge of the film sheet 26 so as to be read by the exposure measurement device 54. Of course, were the step wedge otherwise located on the film sheet 26 the measurement device 54 would be correspondingly located in the apparatus 10.

The electronic exposure control system 58 is used to control the intensity of the actinic radiation incident on the film surface 26I through the CRT 34. The control system 58 comprises a data storage device 62 operative on command to store and to retrieve image data in digital form. The storage device 62 contains a digital representation of the intensity of each of a predetermined number of pixels corresponding to an image to be reproduced. Each intensity level is used to modulate the intensity of the actinic radiation produced from the CRT to create a latent image on the surface 26I of the film sheet 26. The device 62 may also include functional elements enabling it to receive the digital data representative of the image from a remote source. It may also include an input/output interface for operator control.

The data storage device 62 is connected at its output to an exposure level signal generator 64 that modifies the digital representation of the exposure intensity level for each pixel in accordance with a predetermined value stored in a dynamically corrected look-up table produced in a look-up table generator 66. The output of the exposure level signal generator 66 is stored in a temporary buffer element 68 and then applied through a CRT driver 70 to the CRT 34. Preferably the CRT is protected from burnout using circuitry known in the art.

A step wedge generator 72 is also connected to the exposure level signal generator 64, modified in accordance with the look-up table, to produce an output from the CRT 34 to generate the latent image of the step wedge. The generator 66 contains means for generating a set of correction values which are applied to modify a table of exposure correction factors. The exposure correction factors are used to determine the intensity of the imaging beam needed to reproduce in the final toned image the original optical density value of each pixel.

The electronic exposure control system 58 also includes a suitable an analog-to-digital converter 74 operatively associated with the measurement device 54 to produce a digital signal representative of the actual optical densities of the toned step wedge image. These digital signals are applied to the look-up table generator 66. The manner in which the predetermined values in the table are derived in the generator 66 is explained in full detail hereafter. The functional elements 62, 64, 66, 68 and 72 are preferably implemented in a computer system using a Motorola 68000 microprocessor as the central processing unit (CPU). A computer program of twenty-six pages, A-1 through A-26, in M68000 assembly and "C" source language whereby the functions 64A, 66 and 72 are performed as well as the manner for generating the look-up table and for correcting the exposure intensity level is appended to and forms part of this application. The functions 62 and 68 are memories implemented in the hardware of the computer system.

The basis upon which the look-up table is dynamically corrected in the generator 66 is believed best understood from the following discussion. With reference to Figure 3 there are shown four curves which are helpful in explaining the generation and dynamic correction of the look-up table according to this invention. The four quadrants A, B, C and D and curves I, II, III and IV represent various relation ships between different elements cooperating to reproduce an image. The upper right hand quandrant A shows an imaging element transfer function Curve No. I, as the relationship between the residual charge density on the surface of a precharged imaging element as a function of exposure of the element to actinic radiation. Following standard practice, the logarithm of the exposure (Log E) is used as the abscissa.

The upper left quadrant B contains the transfer function of the toner in the form of optical density as a function of charge density (Curve No. II). The lower left quadrant C is simply a transfer curve T to transf r optical densities between the vertical optical density axis and the horizontal optical density axis. Optical densities are represented here in terms of fifteen equidistant steps spanning the range of optical densities available in this system.

The lower right quadrant D represents the graph of the look-up table. Curve No. III is a linear function extending from a minimum illumination corresponding to a maximum optical density step fifteen to a maximum illumination level E_m (Maximum Exposure) corresponding to a minimum optical density level. Curve No. IV is the result of the modifications brought to Curve No. III to provide a predictably accurate reproduction of a desired optical density range and forms the basis for generating the look-up table. Curve No. IV must be generated; otherwise, due to non-linearities in the ton r transfer function Curve No. II and in the imaging element transfer function Curve No. I, the reproduced toned range in the final image will be unacceptable.

As an example, assume for instance, that a desired final optical density is a step 7. Following the solid

lines in Figure 3, it is seen from Curve No. III that a level E1 exposure should be given. That level E1 of exposure results in a charge density D1 on the film sheet surface 26I. As a result of this charge density D1 enough toner will adhere to produce a density step equivalent to 11.6 rather than the desired step 7. The exposure level should, therefore, be changed to give the needed step 7. To reproduce a step 7, based on the toner transfer function Curve No. II, the film sheet must have a charge density D2 as shown by following the dotted line. This in turn will be obtained by exposing the film sheet to an exposure level E2, substantially different from the originally predicted E1. This difference between the two exposures is generated and used by this invention to obtain correct exposures, in the following manner.

Referring to Figure 4, the combined effects of Curves No. I and II from Figure 3 are shown as a combined actual transfer function of the full system, Curve No. V. Practically, this curve is not known, so Curve No. IV, which constitutes the look-up table, cannot be precalculated. During the initialization process of the system a response such as Curve No. III is assumed and a film sheet is exposed to a test target, such as the fifteen optical density level step wedge, to produce a test target image of a predetermined number of known optical density levels. Following development of the test target the optical density levels produced are measured and compared to the known input levels. For instance, it is seen by following the solid lines that a density step 5 is reproduced based on Curve No. III as a step 7 since the exposure given is E1. However, from the measured values on the test target it is known that an exposure E2 produces a step 5 by following the dotted lines. Therefore, Point Q1 on Curve No. III should be corrected by displacing to a positive Q2 such that $Q2-Q1 = E2-E1$. The correction values for all density steps are calculated whenever a value falls between two step wedge values an interpolation to accurately calculate the value needed to reproduce the desired optical density. These values are used to derive Curve No. IV and to generate a look-up table corresponding to Curve No. IV in the look-up table generator 66.

The look-up table is dynamically corrected. Each time an image is produced on an film sheet a test target is also produced in a non-image area of the imaging element. The apparent optical density of the test target is measured by the measurement device 54, converted to a digital quantity by the converter 74, compared to the known optical density values, and the results used to modify the look-up table accordingly to correct for any discrepancies as may have arisen. Such discrepancies may be due, for example, to changes in the film sheet response, to toner changes or to light source intensity level variations, or to atmospheric conditions which may effect the rate of discharge through the photoconductor or other changes. In cases where the required maximum optical density falls outside the range of the look-up table the scorotron film sheet charging characteristics may be adjusted accordingly to produce the needed result. Typically, the toning station includes a bias electrode having a given voltage which controls the amount of toner adhered to the image surface 26I. In cases where the desired minimum density falls outside the look-up table range the bias electrode voltage may be adjusted to bring the minimum density within the look-up table range and the intialization repeated. It is also possible to alter the system response in any desired manner by altering the look-up table in a manner not to reproduce a linearly changing test target, but in a manner which emphasizes certain steps more than others according to preselected criteria.

Those skilled in the art having the benefit of the teachings of the present invention as hereinabove set forth may effect numerous modifications thereto. These modifications are, however, to be construed as lying within the scope of the present invention as defined by the appended claims.

```
  1                         ************************************************************
  2                         *       TS5  CONTROL AND IMAGING PROGRAM FOR TEP PROCESSOR RSNA81
  3                         *       WRITE TWICE   TEN LINES APART WITH FEED SEQUENCE
  4                         *
  5                         *       KHB,MAM,AS              10-31-86
  6                         ************************************************************
  7                 00242000          ORG     $242000
  8   00242000 4FFAFFFE     START     LEA     START(PC),A7        INIT STACK POINTER
  9   00242004 45F900FF4087           LEA     $FF4087,A2          POINTER TO DIO CARD DATA DIREC REG
 10   0024200A 61000746               BSR     CLRPORT             SET PORT 0 TO OUTPUT AND CLEAR OUTPUTS
 11   0024200E 45F900FF4088           LEA     $FF4088,A2          POINTER TO DIO CARD PORT 0 OUTPUTS
 12   00242014 6100072A               BSR     HOMESENS            LOOK AT HOME SENSOR
 13   00242018 08010001               BTST    #1,D1
 14   0024201C 66000022               BNE     RESTART             AT HOME POSITION
 15   00242020 4BFA025F               LEA     HOM1(PC),A5         MOVE DRUM HOME MESSAGE
 16   00242024 4DFA023A               LEA     HOM2(PC),A6
 17   00242028 4E4F                   TRAP    #15
 18   0024202A 0006                   DC.W    OUTPUT
 19   0024202C 6100082A               BSR     BEEP5               5 BEEP
 20   00242030 6100076C               BSR     TRANSFOR            FORWARD TRANSPORT DRIVE
 21   00242034 6100074C               BSR     TRANSON
 22   00242038 6100070C               BSR     HOMESEE             LOOK FOR HOME SENSOR
 23   0024203C 6100074E               BSR     TRANSOFF
 24   00242040 4BFA0206     RESTART   LEA     H1(PC),A5           HELLO MESSAGE
 25   00242044 4DFA023B               LEA     H2(PC),A6
 26   00242048 4E4F                   TRAP    #15
 27   0024204A 0006                   DC.W    OUTPUT
 28   0024204C 13FC00000000           MOVE.B  #0,PASS             CLEAR MEMORY LOCATION
              23AB
 29   00242054 23FC00300000           MOVE.L  #IMAGIBAS,IMAGEMEM  SETUP FOR FIRST IMAGE
              000023AC
 30   0024205E 610004EC               BSR     IMG_INIT            BLANK THE CRT AND CENTER IT
 31   00242062 610007A4               BSR     FSHTRON             TURN ON FUSING POWER
 32   00242066 610007B0               BSR     FSFEDON             TURN ON FUSING SPEED
 33   0024206A 4BFA0254               LEA     STR1(PC),A5
 34   0024206E 4DFA0277               LEA     STR2(PC),A6
 35   00242072 4E4F                   TRAP    #15
 36   00242074 0006                   DC.W    OUTPUT
 37   00242076 61000694               BSR     READGO
 38   0024207A 4BFA027F               LEA     FPASS1(PC),A5       FIRST PASS MESSAGE
 39   0024207E 4DFA0299               LEA     FPASS2(PC),A6
 40   00242082 4E4F                   TRAP    #15
 41   00242084 0006                   DC.W    OUTPUT
 42   00242086 4BFA026F     RERESTRT  LEA     FFSA1(PC),A5
 43   0024208A 4DFA026F               LEA     FFSA2(PC),A6
 44   0024208E 4E4F                   TRAP    #15
 45   00242090 0006                   DC.W    OUTPUT
 46   00242092 61000816               BSR     FEEDFILM            INITIATE FILM FEED
 47   00242096 61000750               BSR     VACUMON             TURN ON VACUUM
 48   0024209A 610006E6               BSR     TRANSON
 49   0024209E 7E0D                   MOVE.L  #13,D7              14 TRANSITIONS BETWEEN LAY DOWN
 50                         *                                     AND START OF SCOROTRON
 51   002420A0 1A3C0001               MOVE.B  #$01,D5             LOOK FOR WHITE FIRST
 52   002420A4 610006B4               BSR     COUNTER
 53   002420A8 610006E2               BSR     TRANSOFF
 54   002420AC 61000752               BSR     VACUMOFF
 55   002420B0 4BFA0236               LEA     MSG1(PC),A5
 56   002420B4 4DFA02A4               LEA     MSG2(PC),A6
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LISTING FOR EXPOSURE LEVEL SIGNAL GENERATOR

64

(PGS A-1 TO A-18)

THE BRACKETED PORTIONS OF CODE ON PAGES A-6 AND A-7, A-8 AND A-9 AND A-10 CONTROL THE SCAN OF IMAGE INFORMATION ON THE CRT

```
 57   00242088 4E4F              TRAP    #15
 58   0024208A 0006              DC.W    OUTPUT
 59   0024208C 6100FFC          BSR     RDYLTON          TURN ON READY LIGHT
 60   00242090 6100064A          BSR     READGO           READ THE GO BUTTON
 61   00242094 6100FFE          BSR     RDYLTOFF         TURN OFF READY LIGHT
 62   00242098 4EFA0290          LEA     GOB1(PC),A5
 63   0024209C 4DFA029E          LEA     GOB2(PC),A6      MESSAGE AFTER GO BUTTON
 64   002420A0 4E4F              TRAP    #15
 65   002420A2 0006              DC.W    OUTPUT
 66   002420A4 61000712          BSR     VACUMON
 67   002420A8 7E09              MOVE.L  #9,D7            ONE SECOND TILL VACUUM PULLS DOWN
 68   002420AA 61000620          BSR     SECOND
 69   002420AE 610006A2          BSR     TRANSON          TURN ON DC MOTOR
 70   002420B2 610006C4          BSR     CHARGON          TURN ON SCOROTRON
 71   002420B6 7E02              MOVE.L  #2,D7            3 TRANSITIONS BETWEEN CHARGEON AND
 72                              *                        DRYER ON
 73   002420B8 1A3C0001          MOVE.B  #$01,D5          LOOK FOR WHITE FIRST
 74   002420BC 6100063C          BSR     COUNTER
 75   002420F0 610007B2          BSR     FILMSENS         CHECK FILM PRESENCE SENSOR AT SCOROTRON
 76   002420F4 08010003          BTST    #3,D1            CHECK FILM PRESENCE BIT
 77   002420F8 67000054          BEQ     FILMPASS         FILM IS SENSED
 78   002420FC 610006B2          BSR     CHARGOFF
 79   00242100 610006FE          BSR     VACUMOFF
 80   00242104 4EFA0283          LEA     FFE1(PC),A5      FILM FEED ERROR MESSAGE
 81   00242108 4DFA02A1          LEA     FFE2(PC),A6
 82   0024210C 4E4F              TRAP    #15
 83   0024210E 0006              DC.W    OUTPUT
 84   00242110 6100067A          BSR     TRANSOFF
 85   00242114 6100067E          BSR     TRANSREV         REVERSE TRANSPORT DRIVE
 86   00242118 7E02              MOVE.L  #2,D7
 87   0024211A 610005E0          BSR     SECOND           300MS TO LET DRUM STOP
 88   0024211E 61000662          BSR     TRANSON
 89   00242122 61000734          BSR     BEEP5            FIVE BEEPS IS FAILURE SIGNAL
 90   00242126 6100061E          BSR     HOMESEE          SEND TRANSPORT HOME
 91   0024212A 7E13              MOVE.L  #19,D7           REVERSE DRIVE TRANSPORT 1.0 INCH PAST
 92   0024212C 610005CE          BSR     SECOND           HOME SENSOR (2 SECONDS)
 93   00242130 6100065A          BSR     TRANSOFF
 94   00242134 7E04              MOVE.L  #4,D7
 95   00242136 610005C4          BSR     SECOND           500 MS TO LET TRANSPORT STOP
 96   0024213A 61000662          BSR     TRANSFOR         FORWARD TRANSPORT DRIVE
 97   0024213E 61000642          BSR     TRANSON
 98   00242142 61000602          BSR     HOMESEE          SEND TRANSPORT HOME
 99   00242146 61000644          BSR     TRANSOFF
100   0024214A 6000FEF4          BRA     RESTART          RESTART PROCESS
101
102   0024214E 7E09        FILMPASS MOVE.L  #9,D7           10 TRANSITIONS BETWEEN DRYERON AND
103                              *                        THE START OF IMAGING
104   00242150 1A3C0001          MOVE.B  #$01,D5          LOOK FOR WHITE FIRST
105   00242154 610007D4          BSR     COUNTER
106   00242158 7E00              MOVE.L  #0,D7            100 MS DELAY
107   0024215A 610005A0          BSR     SECOND
108   0024215E 610006B0          BSR     FSHTROFF         TURN OFF FUSING POWER
109
110   00242162 6100066A          BSR     TONERON          TURN ON TONER PUMP
111                              *       BSR     DRYERON  TURN ON DRYER
112   00242166 00000022          OR.B    #$22,D0          SET DEV ELEC. AND DRYER BITS IN D3 (IMAGE
113                              *                        WILL TURN ON THESE BITS ON PORT 3)
114   0024216A 61000244          BSR     IMAGE            CRT EXPOSURE
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115  00242168 52390000023AB        ADD.B   #1,PASS         INCREMENT PASS COUNTER
116  00242174 61000692             BSR     FSHTRON         TURN ON FUSING POWER
117  00242178 61000636             BSR     CHARGOFF        TURN OFF SCOROTRON
118  0024217C 7E02                 MOVE.L  #2,D7           3 TRANSITIONS BETWEEN END OF IMAGING
119                                *                       AND AIR PULSE
120  0024217E 1A3C0001             MOVE.B  #1,D5           LOOK FOR WHITE FIRST
121  00242182 610007A6             BSR     COUNTER
122  00242186 610006A0             BSR     AIRPULSE        PULSE SOLENOID VALVE TO LIFT FILM
123  0024218A 7E02                 MOVE.L  #2,D7           3 TRANSITIONS BETWEEN END OF AIRPULSE
124                                *                       AND FUSING CAM MOTOR DOWN
125  0024218C 163C0001             MOVE.B  #1,D3           LOOK FOR WHITE FIRST
126  00242190 61000798             BSR     COUNTER
127  00242194 610006D2             BSR     CAMDOWN         TURN FUSING CAM MOTOR TO LOWER ROLLER
128  00242198 7E13                 MOVE.L  #19,D7          20 TRANSITIONS BETWEEN END OF AIR PULSE
129                                *                       AND TONER/DEV ELEC OFF
130  0024219A 1A3C0001             MOVE.B  #1,D5           LOOK FOR WHITE FIRST
131  0024219E 610007BA             BSR     COUNTER
132  002421A2 6100053A             BSR     DEVELOFF        TURN OFF DEVELOPMENT ELECTRODE
133  002421A6 6100062E             BSR     TONEROFF        TURN OFF TONER PUMP
134  002421AA 7E04                 MOVE.L  #4,D7           .5 SEC DELAY TO AVOID BLIPS
135  002421AC 6100054E             BSR     SECOND
136  002421B0 61000594             BSR     HOMESEE         WAIT FOR HOME SENSOR
137  002421B4 7E1D                 MOVE.L  #29,D7          CONTINUE MOVING TRANSPORT FOR ANOTHER 1.6
138  002421B6 61000544             BSR     SECOND          INCH(3 SECS) TO FREE FILM AT DRYER ROLLER
139  002421BA 610005D0             BSR     TRANSOFF        TURN OFF DC MOTOR
140  002421BE 7E04                 MOVE.L  #4,D7
141  002421C0 6100053A             BSR     SECOND          500 MS DELAY TO STOP DRUM
142  002421C4 610005CE             BSR     TRANSREV        REVERSE TRANSPORT DRIVE
143  002421C8 610005B8             BSR     TRANSON
144  002421CC 61000578             BSR     HOMESEE
145  002421D0 7E13                 MOVE.L  #19,D7          2 SECONDS IN REVERSE DIRECTION PAST HOME
146  002421D2 61000528             BSR     SECOND
147  002421D6 610005B4             BSR     TRANSOFF        TURN OFF DC MOTOR
148  002421DA 7E04                 MOVE.L  #4,D7
149  002421DC 6100051E             BSR     SECOND          500 MS DELAY TO STOP DRUM
150  002421E0 610005BC             BSR     TRANSFOR        FORWARD TRANSPORT DRIVE
151  002421E4 6100059C             BSR     TRANSON
152  002421E8 6100055C             BSR     HOMESEE
153  002421EC 6100059E             BSR     TRANSOFF
154  002421F0 6100060E             BSR     VACUMOFF        TURN OFF VACUUM
155  002421F4 7E40                 MOVE.L  #64,D7
156  002421F6 61000504             BSR     SECOND          6.5 SECONDS ADDT'L FOR DRYING
157  002421FA 6100057E             BSR     DRYEROFF        AND FUSING
158  002421FE 61000684             BSR     CAMUP
159  00242202 4BFA0168             LEA     CONG(PC),A5
160  00242206 4DFA0181             LEA     CONG2(PC),A6
161  0024220A 4E4F                 TRAP    #15
162  0024220C 0005                 DC.W    OUTPUT
163  0024220E 61000630             BSR     BEEP            BEEP SUCCESSFUL COMPLETION
164  00242212 6100062C             BSR     BEEP            EACH BEEP IS 500 MSEC
165  00242216 61000628             BSR     BEEP            WITH NO WAIT IN
166  0024221A 61000624             BSR     BEEP            BETWEEN
167
168  0024221E 0C3900020000         CMPI.B  #2,PASS         CHECK PASS #
                23AB
169  00242226 6700FE18             BEQ     RESTART         BRANCH FOR NEXT SHOW
170
171  0024222A 4BFA00ED             LEA     SPASS1(PC),A5   SECOND PASS MESSAGE
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00242232 4E4F                TRAP    #15
00242234 0006                DC.W    OUTPUT
00242236 23FC00590000        MOVE.L  #IMAG2BAS,IMAGEMEM    SETUP FOR SECOND IMAGE
         00023AC
00242240 6100030A            BSR     IMG_INIT              INITIALIZE DMA, TIMER, LUT AND CRT

00242244 6000FE40            BRA     RERESTRT              BRANCH FOR SECOND IMAGE


00242248 0A0A0A0A0A0A HI     DC.B    $A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A
0024225A 0A0A0A0A4D65        DC.B    $A,$A,$A,$A,'Medical Hardcopy RSNA 81 machine',$D,$A,$A
         00242281    H2      EQU     *

00242281 0A0A0A0A0A0A HOM1   DC.B    $A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A,$A
00242293 0A0A0A0A4452        DC.B    $A,$A,$A,$A,'DRUM ROTATING TO HOME AFTER FILM ERROR',$D,$A,$A
         002422C0    HOM2    EQU     *

002422C0 505245535320 STR1   DC.B    'PRESS GO BUTTON FOR INITIAL FILM FEED',$D,$A
         002422E7    STR2    EQU     *

002422E7 46494C4D2046 FFSA1  DC.B    'FILM FEED SEQUENCE',$D,$A
         002422FB    FFSA2   EQU     *

002422FB 424547494E4E FPASS1 DC.B    'BEGINNING FIRST FILM PROCESS',$D,$A
         00242319    FPASS2  EQU     *

00242319 424547494E4E SPASS1 DC.B    'BEGINNING SECOND FILM PROCESS',$D,$A
         00242338    SPASS2  EQU     *

00242338 505245535320 WGB1   DC.B    'PRESS GO BUTTON TO START IMAGING',$D,$A
         0024235A    WGB2    EQU     *

0024235A 494D4147494E GOB1   DC.B    'IMAGING SEQUENCE',$D,$A
         0024236C    GOB2    EQU     *

0024236C 494D4147494E CONG   DC.B    'IMAGING SEQUENCE COMPLETED',$D,$A,$A
         00242389    CONG2   EQU     *

00242389 0A0A2A2A2A2A FFE1   DC.B    $A,$A,'*****  FILM FEED ERROR  *****',$D,$A,$A
         002423AB    FFE2    EQU     *
                             *
                             *       EQUATES
         00000000    MONITOR EQU     $0
         00000001    INPUT   EQU     $1
         00000006    OUTPUT  EQU     $6
         00240000    DOSBASE EQU     $240000
002423AB 00000001    PAS1    DS.B    1
         000023AB    PASS    EQU     PAS1-DOSBASE
         0000A000    ZLUT    EQU     $A000                 Z LOOK-UP TABLE ADDRESS
                             *       IMAGE MEMORY LAYOUT DEFINITIONS
         0000010E    TM      EQU     270                   TOP MARGIN (IN LINES)
         00000028    TCS     EQU     40                    TOP CENTER SPACE (IN LINES)
         00000028    BCS     EQU     40                    BOTTOM CENTER SPACE (IN LINES)
         00000028    BM      EQU     40                    BOTTOM MARGIN (IN LINES)
         00000001    RC      EQU     1                     NUMBER OF TIMES TO REPEAT FRAME LINE
         000001E0    FL      EQU     480*RC                TOTAL NUMBER OF LINES PER FRAME
         00000726    PL      EQU     34FL+TM+TCS+BCS+BM    TOTAL NUMBER OF LINES PER PAGE
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                00000047    LM        EQU     71                  LEFT MARGIN (IN PIXELS)
                00000004    CS        EQU     4                   CENTER SPACE (IN PIXELS)
                00000047    RM        EQU     71                  RIGHT MARGIN (IN PIXELS)
                00000434    LL        EQU     LM+CS+RM+1024+2     NUMBER OF PIXELS PER LINE
                00300000    IMAG1BAS  EQU     $300000             START OF FIRST IMAGE
                00580000    IMAG2BAS  EQU     $580000             START OF SECOND IMAGE
002423AC 00000004 IMAGEASE  DS.L    1                           IMAGE BASE ADR STORAGE ADR
                000023AC    IMAGEMEM  EQU     IMAGBASE-DOSBASE    PTR TO STORAGE ADR
                0050E9F8    BLANKLIN  EQU     (IMAG1BAS+LL*PL+1)&$FFFFFFFE BLANK LINE
                            *
                            *
                            *       DMA Controller Register Definitions
                            *
                00FF0800    DMABASE   EQU     $FF0000             BASE ADDRESS OF DMA BOARD
                00000000    CHAN0     EQU     $0                  DMA CHANNEL 0
                00000040    CHAN1     EQU     $40                 DMA CHANNEL 1
                00000000    DMACSR    EQU     0                   DMA CHANNEL STATUS REGISTER
                00000001    DMACER    EQU     1                   DMA CHANNEL ERROR REGISTER
                00000004    DMADCR    EQU     4                   DMA DEVICE CONTROL REGISTER
                00000005    DMAOCR    EQU     5                   DMA OPERATION CONTROL REGISTER
                00000006    DMASCR    EQU     6                   DMA SEQUENCE CONTROL REGISTER
                00000007    DMACCR    EQU     7                   DMA CHANNEL CONTROL REGISTER
                0000000A    DMAMTC    EQU     $A                  DMA MEMORY TRANSFER COUNT
                0000000C    DMAMAR    EQU     $C                  DMA MEMORY ADDRESS REGISTER
                00000014    DMADAR    EQU     $14                 DMA DEVICE ADDRESS REGISTER
                0000001A    DMABTC    EQU     $1A                 DMA BASE TRANSFER COUNT
                0000001C    DMABAR    EQU     $1C                 DMA BASE ADDRESS REGISTER
                00000025    DMANIN    EQU     $25                 DMA NORMAL INTERRUPT VECTOR REG
                00000027    DMAEIN    EQU     $27                 DMA ERROR INTERRUPT VECTOR REG
                0000002D    DMACPR    EQU     $2D                 DMA CHANNEL PRIORITY REGISTER
                00000029    DMAMFC    EQU     $29                 DMA MEMORY FUNCTION CODE REGISTER
                00000031    DMADFC    EQU     $31                 DMA DEVICE FUNCTION CODE REGISTER
                00000039    DMABFC    EQU     $39                 DMA BASE FUNCTION CODE REGISTER
                000000FF    DMAGCR    EQU     $FF                 DMA GENERAL CONTROL REGISTER
                            *
                            *
                            *
                            *       Timer Controller Register Definitions
                            *
                00FF0900    TMRDAT    EQU     $FF0900             TIMER DATA REGISTER (W)
                00FF0902    TMRCTL    EQU     $FF0902             TIMER CONTROL REGISTER (W)
                0000FF70    STRPXC    EQU     $FF70               START PIXEL CLOCK COMMAND
                0000FFD0    STPPXC    EQU     $FFD0               STOP PIXEL CLOCK COMMAND
                00FF0902    TMRSTA    EQU     $FF0902             TIMER STATUS REGISTER (W) DATA=LOW BYTE
                            *
                            *       Miscellaneous Register Definitions
                            *
                00FF0904    CRTY_C    EQU     $FF0904             CRT Y AND CONTROL REGISTER (W-WO)
                00FF0904    DENSEL    EQU     $FF0904             DENSITY DATA (W-RO) DATA IN LOW BYTE
                00FF0908    ZSEL      EQU     $FF0908             Z DATA OUTPUT REGISTER (W-WO)
                00FF090C    FGCTL     EQU     $FF090C             FRAME-GRABBER CONTROL REGISTER (W-WO)
                00FF0A00    LUTBASE   EQU     $FF0A00             LUT BASE ADDRESS
                            *
                            *
                FFFFFFFF    BEAMOFF   EQU     $FFFFFFFF           DATA FOR CRT BEAM OFF
                00000000    PIXLOFF   EQU     $00000000           PIXEL DATA FOR CRT BEAM OFF
                            *
                            *
```

```
                        *       REGISTER USAGE:
                        *
                        *       A0      PIXEL DATA (Z)
                        *       A1      NOT USED
                        *       A2      USED TO TURN ON DEVELOPMENT ELECTRODE
                        *       A3      ADDRESS OF CRT Y AND CONTROL REGISTER (CRTY_C)
                        *       A4      NOT USED
                        *       A5      ADDRESS OF TIMER CONTROL REGISTER (TMRCTL)
                        *       A6      ADDRESS OF DMA CONTROLLER (DMABASE)
                        *
                        *       D0      NEXT Y (IN LOW BYTE); CRT CONTROL (IN HIGH BYTE)
                        *       D1      SAME AS ABOVE WITH "LOAD Y" BIT CLEARED
                        *       D2      DMA ERRORS
                        *       D3      NOT USED
                        *       D4      NUMBER OF PIXELS/LINE (DMA TRANSFER COUNT)
                        *       D5      CLEAR DONE BIT
                        *       D6      DMA START AND INTERRUPT ENABLE BITS
                        *       D7      LINES PER PAGE COUNTER
                        *

002423B0 48E7FFFE       IMAGE   MOVEM.L D0-D7/A0-A6,-(SP)       SAVE REGISTERS
002423B4 40E7                   MOVE.W  SR,-(SP)
002423B6 46FC2000               MOVE.W  #$2000,SR
002423BA 6100000E               BSR     NXTLINIT                INITIALIZE NEXTLINE ROUTINE
002423BE 33FCFFFF00FF           MOVE.W  #BEAMOFF,ZSEL           MAKE SURE BEAM IS OFF
         0908
002423C6 4DF900FF0000           LEA     DMABASE,A6              ADDRESS OF DMA CONTROLLER
002423CC 2D4C000C               MOVE.L  A4,CHAN0+DMAMAR(A6)     1ST LINE TO IMAGE (FROM NXTLINIT)
002423D0 47F900FF0904           LEA     CRTY_C,A3
002423D6 3691                   MOVE.W  D1,(A3)                 FIRST Y (FROM NXTLINIT)
002423D8 00410200               OR.W    #$200,D1                NOW LOAD Y
002423DC 3681                   MOVE.W  D1,(A3)                 FIRST Y (FROM NXTLINIT)
002423DE 0241FDFF               AND.W   #$FDFF,D1               TURN LOAD Y BACK OFF
002423E2 3681                   MOVE.W  D1,(A3)
002423E4 1200                   MOVE.B  D0,D1                   COPY NEXT Y
002423E6 4BF900FF0902           LEA     TMRCTL,A5               ADDRESS OF TIMER CONTROL REGISTER
002423EC 4262                   CLR.L   D2
002423EE 283C00000494           MOVE.L  #LL,D4
002423F4 3D44000A               MOVE.W  D4,CHAN0+DMAMTC(A6)
002423F8 2A3C00000000           MOVE.L  #$00,D5                 DONE BIT
002423FE 2C3C00000088           MOVE.L  #$88,D6                 START AND INTERRUPT ENABLE
00242404 2E3C00000E5F           MOVE.L  #((PL+LOFFSET)*NWRITES)-1,D7 SET LINES PER PAGE
0024240A 6100026E               BSR     DMACLR                  CLEAR OUT LAST COMMAND
0024240E 08160001       IMAGE1  BTST.B  #1,CHAN0+DMACSR(A6)     IN HORIZONTAL BLANKING INTERVAL?
00242412 67FA                   BEQ     IMAGE1                  IF EQ NO
00242414 1D460007               MOVE.B  D6,CHAN0+DMACCR(A6)     YES - START TRANSFER
00242418 44FC0000               MOVE    #0,CCR                  CLEAR CARRY
0024241C 3ABCFF70               MOVE.W  #STRPXC,(A5)            START PIXEL CLOCK
00242420 60000016               BRA     IMAGE3
00242424 2D48000C       IMAGE2  MOVE.L  A0,CHAN0+DMAMAR(A6)
00242428 3D44000A               MOVE.W  D4,CHAN0+DMAMTC(A6)
0024242C 1D460007               MOVE.B  D6,CHAN0+DMACCR(A6)     CONTINUE TRANSFER
00242430 610000A2               BSR     NEXTLINE                SET-UP NEXT LINE
00242434 44FC0000               MOVE.W  #0,CCR                  CLEAR CARRY
00242438 6400FFFE       IMAGE3  BCC     IMAGE3                  WAIT FOR INTERRUPT
0024243C 3680                   MOVE.W  D0,(A3)                 NEXT Y
0024243E 3681                   MOVE.W  D1,(A3)                 RESET LOAD Y
00242440 0C87000000FC           CMP.L   #2300,D7
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00242446 67000018            BEQ     DEVELON
0024244A 51CFFFD8  CONTINU   DBF     D7,IMAGE2           DO ALL LINES
0024244E 3ABCFFD0            MOVE.W  #STPPIC,(A5)        YES, STOP PIXEL CLOCK
00242452 0241FEFF            AND.W   #$FEFF,D1           DROP VIDEO ACTIVE
00242456 3681                MOVE.W  D1,(A3)
00242458 46DF                MOVE.W  (SP)+,SR
0024245A 4CDF7FFF            MOVEM.L (SP)+,D0-D7/A0-A6   RESTORE REGISTERS
0024245E 4E75                RTS

00242460 45F900FF4008 DEVELON LEA    $FF4008,A2          DIO PORT 0 ADDRESS
00242466 1012                MOVE.B  (A2),D0             READ DIO PORT
00242468 00000022            OR.B    #$22,D0             TURN ON DRYER AND DEV ELEC BITS
0024246C 1480                MOVE.B  D0,(A2)             TURN THEM ON
0024246E 60DA                BRA     CONTINU

                     *
                     *
                     * INTERRUPT SERVICE ROUTINE
                     *
00242470 3416        INTSERV MOVE.W  CHAN0+DMACSR(A6),D2
00242472 1C85                MOVE.B  D5,CHAN0+DMACSR(A6) RESET DONE
00242474 0802000C            BTST    #12,D2
00242478 6500000E            BNE     INTSVCA
0024247C 1D7C000000007       MOVE.B  #0,CHAN0+DMACCR(A6) DISABLE INTERRUPTS
00242482 00570001            ORI.W   #1,(SP)             SET CARRY BIT
00242486 4E73                RTE

00242488 48F8FFFF6000 INTSVCA MOVEM.L D0-D7/A0-A7,$6000
0024248E 40F86040            MOVE.W  SR,$6040
00242492 31FCFFFF6042        MOVE.W  #$FFFF,$6042
00242498 60FE                BRA     *

                     *
                     *
                     * SET-UP DATA FOR NEXT IMAGE LINE
                     *
                     *       NXTLINIT  INITIALIZE NEXTLINE ROUTINE AND SET-UP FIRST LINE
                     *       NEXTLINE  SET-UP NEXT IMAGE LINE
                     *
                     *    REGISTER USAGE:
                     *
                     *       A0        PIXEL DATA (2)
                     *       A2        ADDRESS OF REGISTER SAVE AREA
                     *       A3        ADDRESS OF Y DEFLECTION DATA TABLE
                     *       A4        ADDRESS OF NEXT LINE FOR LOW Y
                     *       A5        ADDRESS OF NEXT LINE FOR HIGH Y
                     *       A6        ADDRESS OF ROUTINE FOR NEXT PART OF IMAGE
                     *
                     *       D0        NEXT Y (IN LOW BYTE)
                     *       D4        INCREMENT TO NEXT LINE FOR LOW Y
                     *       D5        INCREMENT TO NEXT LINE FOR HIGH Y
                     *       D6        LINE REPEAT COUNTER (2)
                     *       D7        COUNT OF LINES IN CURRENT IMAGE SECTION (20,1800,20)
                     *

00000002     NWRITES  EQU     2                   NUMBER OF TIMES TO WRITE EACH LINE
0000000A     LOFFSET  EQU     10                  DISTANCE BETWEEN THE TWO LINES
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                                *
                                *       NEXTLINE IS INITIALIZED TO IMAGE THE FIRST "LOFFSET" LINES
                                *       AT LOW Y AND A BLANK LINE AT HIGH Y
                                *
00242498 283C00000494 NXTLINIT MOVE.L  #LL,D4              LENGTH OF LINE
0024249E 4285                  CLR.L   D5                  NO INCREMENT FOR BLANK LINE
002424A0 7C00                  MOVE.L  #NWRITES-2,D6       LINE REPEAT COUNTER
002424A2 7E09                  MOVE.L  #LOFFSET-1,D7       COUNT FOR FIRST SET OF LINES
002424A6 45FA007E              LEA     NLSAVE(PC),A2       ADDRESS OF REGISTER SAVE AREA
002424AA 47FA009E              LEA     YTABLE(PC),A3       ADDRESS OF Y DEFLECTION TABLE
002424AE 223C00000100          MOVE.L  #$0100,D1           SET CRT CONTROL FOR FIRST LINE
002424B4 203C00000300          MOVE.L  #$0300,D0           SET CRT CONTROL FOR SECOND LINE
002424BA 1218                  MOVE.B  (A3)+,D1            ADD IN Y DEFLECTION FOR 1ST LINE
002424BC 1018                  MOVE.B  (A3)+,D0            ADD IN Y DEFLECTION FOR 2ND LINE
002424BE 2E7823AC              MOVEA.L IMAGEMEM,A4         ADDR OF LINE FOR LOW Y (1ST LINE)
002424C2 4BF900050B9F8         LEA     BLANKLIN,A5         ADDRESS OF LINE FOR HIGH Y
002424C8 204D                  MOVE.L  A5,A0               SECOND LINE TO IMAGE
002424CA 4DFA003A              LEA     NLMID(PC),A6        ADDRESS OF ROUTINE FOR MIDDLE
002424CE 48D27CF0              MOVEM.L D4-D7/A2-A6,(A2)    SAVE NEXTLINE REGISTERS
002424D2 4E75                  RTS

002424D4 48E7CF3E      NEXTLINE MOVEM.L D4-D7/A2-A6,-(SP)  SAVE REGISTERS
002424D8 4CFA7CF0004A          MOVEM.L NLSAVE(PC),D4-D7/A2-A6 GET REGISTERS FOR THIS ROUTINE
002424DE 204D                  MOVE.L  A5,A0               SET ADDRESS FOR NEXT LINE
002424E0 51CE0016              DBF     D6,NEXTEXIT         COUNT DOWN LINE REPEAT COUNT
002424E4 51CF0004              DBF     D7,NEXTREP          DONE THIS PART OF IMAGE?
002424E8 4ED6                  JMP     (A6)                YES - SET UP NEXT PART

002424EA D8C4          NEXTREP ADDA.W  D4,A4               NEXT LINE FOR LOW Y
002424EC DAC5                  ADDA.W  D5,A5               NEXT LINE FOR HIGH Y
002424EE 204C                  MOVE.L  A4,A0               NEXT LINE IS LOW Y
002424F0 3C3C0001              MOVE.W  #NWRITES-1,D6       RESET REPEAT COUNT
002424F4 47FA0054              LEA     YTABLE(PC),A3       RESET Y DEFLECTION TABLE ADDRESS
002424F8 1013          NEXTEXIT MOVE.B  (A3),D0             NEXT Y
002424FA 1218                  MOVE.B  (A3)+,D1
002424FC 48D27CF0              MOVEM.L D4-D7/A2-A6,(A2)    SAVE NEXTLINE REGISTERS
00242500 4CDF7CF0              MOVEM.L (SP)+,D4-D7/A2-A6   RESTORE REGISTERS
00242504 4E75                  RTS

                                *
                                *       ENTERED AFTER "LOFFSET" LINES HAVE BEEN IMAGED AT LOW Y
                                *       AND NOTHING IMAGED AT HIGH Y.  BY NOW, IMAGE LINE 1 HAS
                                *       MOVED UNDER THE HIGH Y POSITION.
                                *
                                *       FOR MIDDLE OF IMAGE, WRITE NEXT IMAGE LINE ON LOW Y
                                *       AND NEXT + "LOFFSET" IMAGE LINE ON HIGH Y
                                *

00242506 3A04          NLMID   MOVE.W  D4,D5               SET INCREMENT ON HIGH Y
00242508 2A7823AC              MOVEA.L IMAGEMEM,A5         IMAGE LINE 1 ON HIGH Y
0024250C 9BFC00000494          SUBA.L  #LL,A5
00242512 3E3C0718              MOVE.W  #PL-LOFFSET-1,D7    IMAGE REMAINDER OF LINES
00242516 4DFA0004              LEA     NLEND(PC),A6        SET-UP FOR LAST "LOFFSET" LINES
0024251A 60CE                  BRA     NEXTREP

                                *
                                *       ENTERED AFTER "PL" LINES HAVE BEEN IMAGED AT LOW Y
```

```
460                     *       AND "PL-LOFFSET" LINES IMAGED AT HIGH Y.  NOW, IMAGE
461                     *       LAST "LOFFSET" LINES AT THE HIGH Y POSITION.
462                     *
463                     *       FOR END OF IMAGE, WRITE NEXT IMAGE LINE ON HIGH Y
464                     *       AND BLANK IMAGE LINE ON LOW Y
465                     *
466
467 00242518 49F900050B9F8 NLEND  LEA     BLANKLIN,A4             IMAGE BLANK LINE ON LOW Y
468 00242522 4244               CLR.W   D4                      NO INCREMENT FOR LOW Y
469 00242524 60C4               BRA     NEXTREP
470
471 00242526 00000024   NLSAVE  DS.L    9                       SPACE TO SAVE 9 REGISTERS
472 0024254A 10         YTABLE  DC.B    $10                     LOW Y
473 0024254B F0                 DC.B    $F0                     HIGH Y
474
475                     *
476                     * INITIALIZE CRT INTERFACE
477                     *
478 0024254C 48E7FFFE   IMG_INIT MOVEM.L D0-D7/A0-A6,-(SP)      SAVE REGISTERS
479 00242550 61000142           BSR     TMR_INI                 INITIALIZE TIMER CONTROLLER
480 00242554 61000048           BSR     LUT_INI                 INITIALIZE LOOK-UP TABLE
481 00242558 61000066           BSR     DMA_INI                 INITIALIZE DMA CONTROLLER
482                     *       BSR      CALCRT                       CALIBRATE CRT
483 0024255C 61000032           BSR     BLANKCRT                BLANK CRT
484 00242560 207823AC           MOVEA.L IMAGEMEM,A0             SET LAST 2 PIXELS OF EACH
485 00242564 2248               MOVEA.L A0,A1
486 00242566 D3FC0020B9F8       ADDA.L  #(LL*PL),A1             LINE TO TURN OFF CRT BEAM
487 0024256C 7000               MOVE.L  #PIXLOFF,D0
488 0024256E D0FC0492   IMG_IN1 ADDA.W  #(LL-2),A0
489 00242572 10C0               MOVE.B  D0,(A0)+
490 00242574 10C0               MOVE.B  D0,(A0)+
491 00242576 B3C8               CMPA.L  A0,A1
492 00242578 62F4               BHI     IMG_IN1
493 0024257A 41F9005009F8       LEA     BLANKLIN,A0             INITIALIZE BLANK LINE
494 00242580 323C0126           MOVE.W  #LL/4,D1                LONGWORDS ON EACH LINE
495 00242584 20C0       IMG_IN2 MOVE.L  D0,(A0)+
496 00242586 51C9FFFC           DBF     D1,IMG_IN2
497 0024258A 4CDF7FFF           MOVEM.L (SP)+,D0-D7/A0-A6       RESTORE REGISTERS
498 0024258E 4E75               RTS
499                     *
500                     *
501                     * CALIBRATE CRT
502                     *
503                     *
504                     *ALCRT   LEA     CRTY_C,A3
505                     *       MOVE.W  #$0000,ZSEL             TURN ON CRT BEAM
506                     *       MOVE.W  #$007F,(A3)             SET FOR INTENSITY DATA
507                     *       MOVE.W  #$037F,(A3)
508                     *       MOVE.W  #$017F,(A3)
509                     *       MOVE.W  #10,D0                  WAIT 20 USEC
510                     *       DBF     D0,*
511                     *       MOVE.W  #$897F,(A3)             RESET CRT
512                     *       MOVE.W  #$3E00,D1               CALIBRATE BRIGHTNESS
513                     *       MOVE.W  #$3900,D2
514                     *       MOVE.W  #20000,D0               WAIT 100 MSEC
515                     *ALCRT1  MOVE.B  D0,D1
516                     *       MOVE.B  D0,D2
517                     *       MOVE.W  D1,(A3)
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```
                        *       MOVE.W  D2,(A3)
                        *       DBF     D0,CALCRT1
                        *       EOR.W   #$8000,D1               RESET CRT
                        *       EOR.W   #$8000,D2
                        *       MOVE.W  #10000,D0               WAIT 50 MSEC
                        *ALCRT2 MOVE.B  D0,D1                   USE LOW BYTE FOR Y DEFLECTION
                        *       MOVE.B  D0,D2
                        *       MOVE.W  D1,(A3)
                        *       MOVE.W  D2,(A3)
                        *       DBF     D0,CALCRT2
                        *       EOR.W   #$9000,D1               CALIBRATE CONTRAST
                        *       EOR.W   #$9000,D2
                        *       MOVE.W  #20000,D0               WAIT 100 MSEC
                        *ALCRT3 MOVE.B  D0,D1                   USE LOW BYTE FOR Y DEFLECTION
                        *       MOVE.B  D0,D2
                        *       MOVE.W  D1,(A3)
                        *       MOVE.W  D2,(A3)
                        *       DBF     D0,CALCRT3
                        *       MOVE.W  #$027F,(A3)             END OF CALIBRATION
                        *       MOVE.W  #$007F,(A3)
                        *       RTS
                        *
                        *
                        * BLANK CRT
                        *
00242690 33FCFFFF00FF   BLANKCRT MOVE.W  #BEAMOFF,ZSEL          DATA TO BLANK CRT
         0909
00242690 368C007F               MOVE.W  #$007F,(A3)
0024259C 4E75                   RTS


                        *
                        *
                        * INITIALIZE LOOK-UP TABLE (LUT)
                        *
002425AE 47F900FF0904   LUT_INI LEA     CRTY_C,A3               ADDRESS OF CONTROL AND Y
002425A4 368C007F               MOVE.W  #$007F,(A3)             DISABLE VIDEO
002425AB 43F900FF0A00           LEA     LUTBASE,A1              ADDRESS OF EXTERNAL LUT RAM
002425AE 41F90000A000           LEA     ZLUT,A0                 ADDRESS OF LUT LOADED FROM DISK
002425B4 303C00FF               MOVE.W  #256-1,D0               COPY 256 WORDS
002425B8 3208           LUT_IN1 MOVE.W  (A0)+,(A1)+
002425BA 51C8FFFC               DBF     D0,LUT_IN1
002425BE 4E75                   RTS
                        *
                        *
                        * INITIALIZE DMA CONTROLLER
                        *
002425C0 4DF900FF0800   DMA_INI LEA     DMABASE,A6              POINT TO DMA CONTROLLER
002425C6 1D7C00100007           MOVE.B  #$10,CHAN0+DMACCR(A6)   CLEAR OUT ANY ERRORS
002425CC 1D7C00100047           MOVE.B  #$10,CHAN1+DMACCR(A6)
002425D2 08150003       DMAIN1  BTST.B  #3,CHAN0+DMACSR(A6)     DONE?
002425D6 66FA                   BNE     DMAIN1                  IF NE NO
002425D8 082E00030040   DMAIN2  BTST.B  #3,CHAN1+DMACSR(A6)     DONE?
002425DE 66F8                   BNE     DMAIN2                  IF NE NO
002425E0 61000093               BSR     DMACLR                  CLEAR OUT LAST COMMAND
002425E4 1D7C000000FF           MOVE.B  #$00,DMAGCR(A6)         INITIALIZE DMA CONTROLLER
002425EA 1D7C00440025           MOVE.B  #$44,CHAN0+DMAINTR(A6)  INITIALIZE INTERRUPT VECTORS
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575  00242F0 1D7C00440027        MOVE.B  #$44,CHAN0+DMAEIN(A6)
576  00242F6 1D7C00450065        MOVE.B  #$45,CHAN1+DMAMIN(A6)
577  00242FC 1D7C00450067        MOVE.B  #$45,CHAN1+DMAEIN(A6)
578  0024302 41FAFE6C            LEA     INTSERV(PC),A0          SET INTERRUPT VECTOR
579  0024306 21C80110            MOVE.L  A0,$0110
580  002430A 41FA006C            LEA     FGSERV(PC),A0
581  002430E 21C80114            MOVE.L  A0,$0114
582                           *
583  0024312 1D7C00A00004        MOVE.B  #$A0,CHAN0+DMADCR(A6)
584  0024318 1D7C00A00044        MOVE.B  #$A0,CHAN1+DMADCR(A6)
585  002431E 1D7C00020005        MOVE.B  #$02,CHAN0+DMAOCR(A6)
586  0024324 1D7C00020045        MOVE.B  #$02,CHAN1+DMAOCR(A6)
587  002432A 1D7C00040006        MOVE.B  #$04,CHAN0+DMASCR(A6)
588  0024330 1D7C00040046        MOVE.B  #$04,CHAN1+DMASCR(A6)
589  0024336 1D7C0000002D        MOVE.B  #$00,CHAN0+DMACPR(A6)
590  002433C 1D7C0001006D        MOVE.B  #$01,CHAN1+DMACPR(A6)
591  0024342 2D7C00000000        MOVE.L  #$000000,CHAN0+DMADAR(A6) DEVICE ADDRESS NOT USED
                  0014
592  002434A 2D7C00000000        MOVE.L  #$000000,CHAN1+DMADAR(A6)
                  0054
593  0024352 1D7C00060029        MOVE.B  #$06,CHAN0+DMAMFC(A6) ALL DATA IN SUPER MEMORY
594  0024358 1D7C00050031        MOVE.B  #$05,CHAN0+DMADFC(A6)
595  002435E 1D7C00060039        MOVE.B  #$06,CHAN0+DMAEFC(A6)
596  0024364 1D7C00060069        MOVE.B  #$06,CHAN1+DMAMFC(A6)
597  002436A 1D7C00060071        MOVE.B  #$06,CHAN1+DMADFC(A6)
598  0024370 1D7C00050079        MOVE.B  #$05,CHAN1+DMABFC(A6)
599  0024376 4E75                RTS
600
601                           *
602                           * FRAME GRABBER INTERRUPT SERVICE
603                           *
604  0024378 60FE             FGSERV  BRA     *
605
606                           *
607                           * CLEAR OUT PREVIOUS DMA COMMAND AND ERROR
608                           *
609  002437A 1D7C00F20040     DMACLR  MOVE.B  #$F2,CHAN1+DMACSR(A6)
610  0024380 082E00070040             BTST.B  #7,CHAN1+DMACSR(A6)   DONE?
611  0024386 66F2                     BNE     DMACLR                IF NE NO
612  0024388 1CBC00F2         DMACLR1 MOVE.B  #$F2,CHAN0+DMACSR(A6)
613  002438C 08160007                 BTST.B  #7,CHAN0+DMACSR(A6)   DONE?
614  0024390 66F6                     BNE     DMACLR1               IF NE NO
615  0024392 4E75                     RTS
616                           *
617                           *
618                           * INITIALIZE TIMER CONTROLLER
619                           *
620                           *       RESOLUTION IS 0.2 MICROSECONDS PER COUNT
621                           *
622  00000011                 PXLOW   EQU     17                    3.4 USEC PIXEL CLOCK LOW
623  00000005                 PXHIGH  EQU     5                     1.0 USEC PIXEL CLOCK HIGH
624  00000E02                 HRETRACE EQU    1538                  307.6 USEC HORIZONTAL RETRACE
625
626  0024394 4BF900FF0902     TMR_INI LEA     TMRCTL,A5             POINT TO TIMER CONTROL REGISTER
627  002439A 49F900FF0900             LEA     TMRDAT,A4             POINT TO TIMER DATA REGISTER
628  00243A0 47F900FF0904             LEA     CRTV_C,A3             POINT TO CRT CONTROL REGISTER
629  00243A6 36BC007F                 MOVE.W  #$007F,(A3)           TURN OFF VIDEO
630  00243AA 3ABCFFFF                 MOVE.W  #$FFFF,(A5)           RESET TIMER CONTROLLER
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631  002426AE 3ABCFF5F            MOVE.W  #$FF5F,(A5)          LOAD COUNTERS TO CLEAR TC
632  002426B2 3ABCFFEF            MOVE.W  #$FFEF,(A5)          SET TO 16-BIT DATA MODE
633  002426B6 3ABCFF17            MOVE.W  #$FF17,(A5)          SELECT MMR REGISTER
634  002426BA 38BCF000            MOVE.W  #$F000,(A4)          SET TO 16-BIT DATA, BCD SCALE
635  002426BE 3ABCFF05            MOVE.W  #$FF05,(A5)          SELECT COUNTER 5 MODE REGISTER
636  002426C2 38BC8B52            MOVE.W  #$8B52,(A4)          MODE K,5MHZ SRC,TC TOG,GATE S
637  002426C6 3ABCFFED            MOVE.W  #$FFED,(A5)          SET TC HIGH
638  002426CA 3ABCFF0D            MOVE.W  #$FF0D,(A5)          SELECT COUNTER 5 LOAD REGISTER
639  002426CE 38BC0011            MOVE.W  #PXLOW,(A4)          PIXEL CLOCK LOW
640  002426D2 3ABCFF15            MOVE.W  #$FF15,(A5)          SELECT COUNTER 5 HOLD REGISTER
641  002426D6 38BC0005            MOVE.W  #PXHIGH,(A4)         PIXEL CLOCK HIGH
642  002426DA 3ABCFF04            MOVE.W  #$FF04,(A5)          SELECT COUNTER 4 MODE REGISTER
643  002426DE 38BC8B52            MOVE.W  #$8B52,(A4)          MODE J,5MHZ SRC,TC TOG,NO GATE
644  002426E2 3ABCFFE4            MOVE.W  #$FFE4,(A5)          SET COUNTER 4 TC LOW
645  002426E6 3ABCFF14            MOVE.W  #$FF14,(A5)          SELECT COUNTER 4 HOLD REGISTER
646  002426EA 38BC64B9            MOVE.W  #LL&(PXLOW+PXHIGH),(A4) HIGH FOR "LL" PIXELS ON LINE
647  002426EE 3ABCFF0C            MOVE.W  #$FF0C,(A5)          SELECT COUNTER 4 LOAD REGISTER
648  002426F2 38BC0692            MOVE.W  #HRETRACE,(A4)       HORIZONTAL RETRACE TIME
649  002426F6 3ABCFF68            MOVE.W  #$FF68,(A5)          LOAD AND ARM CNTR 4 (SWEEPGATE)
650  002426FA 4E75                RTS
651
652                               *
653                               *  SUBROUTINES
654                               *
655
656  002426FC 2C3C0000FFFF SECOND  MOVE.L  #$FFFF,D6           0.1 SECOND DELAY
657  00242702 51CEFFFE     S1      DBF     D6,S1
658  00242706 51CFFFF4             DBF     D7,SECOND
659  0024270A 4E75                 RTS
660
661  0024270C 122A0001     READGO  MOVE.B  1(A2),D1           READ INPUT REGISTER
662  00242710 08010000             BTST    #0,D1              TEST FOR GO BUTTON PUSHED
663  00242714 66F6                 BNE     READGO             GO BUTTON NOT PUSHED
664  00242716 2C3C00000000         MOVE.L  #$8000,D6          50MS DELAY FOR SWITCH DEBOUNCING
665  0024271C 51CEFFFE     READ1   DBF     D6,READ1
666  00242720 122A0001             MOVE.B  1(A2),D1           READ INPUT REGISTER AGAIN
667  00242724 08010000             BTST    #0,D1              TEST IF GO BUTTON STILL PUSHED
668  00242728 66E2                 BNE     READGO             GO BUTTON NOT STILL PUSHED
669  0024272A 2C3C00008000         MOVE.L  #$8000,D6          50MS DELAY FOR SWITCH DEBOUNCING
670  00242730 51CEFFFE     READ2   DBF     D6,READ2
671  00242734 122A0001             MOVE.B  1(A2),D1           READ INPUT REGISTER A THIRD TIME
672  00242738 08010000             BTST    #0,D1              TEST IF GO BUTTON STILL PUSHED
673  0024273C 66CE                 BNE     READGO             GO BUTTON NOT STILL PUSHED
674  0024273E 4E75                 RTS
675
676  00242740 122A0001     HOMESENS MOVE.B  1(A2),D1          READ PORT 1
677  00242744 4E75                 RTS
678
679  00242746 122A0001     HOMESEE MOVE.B  1(A2),D1           READ INPUT REGISTER
680  0024274A 08010001             BTST    #1,D1              TEST FOR HOME SENSOR
681  0024274E 67F6                 BEQ     HOMESEE
682                               *       MOVE.L  #1,D6
683                               *HOME1   MOVE.L  #$FFFF,D7
684                               *HOMELOOP DBF    D7,HOMELOOP
685                               *       DBF     D6,HOME1
686  00242750 4E75                 RTS
687
688  00242752 14BC0009     CLRPORT MOVE.B  #$09,(A2)          SET DDR PORTS 0 & 3 ARE ALWAYS OUT
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689                                 *                                   PORT1 IS ALWAYS IN & PORT 2 IS BIDIR
690   00242756 157C00000001                 MOVE.B   #$00,1(A2)         CLEAR OUTPUTS ON PORT 0
691   0024275C 157C0001 0003                MOVE.B   #$01,3(A2)         CLEAR OUTPUTS ON PORT 2
692   00242762 157C00000004                 MOVE.B   #$00,4(A2)         CLEAR OUTPUTS ON PORT 3
693   00242768 4240                         CLR      D0                 CLEAR PORT 0 DATA
694   0024276A 4241                         CLR      D1                 CLEAR PORT 1 DATA
695   0024276C 4242                         CLR      D2                 CLEAR PORT 2 DATA
696   0024276E 4243                         CLR      D3                 CLEAR PORT 3 DATA
697   00242770 4E75                         RTS
698                                 * NOTE: NO CONTROL IS DONE USING PORT 0, BIT #2,5 AND 6
699   00242772 00000020           DRYERON   OR.B     #$20,D0            PREPARE CONTROL REGISTER
700   00242776 1480                         MOVE.B   D0,(A2)            TURN DRYER ON
701   00242778 4E75                         RTS
702
703   0024277A 020000DF           DRYEROFF  AND.B    #$DF,D0            PREPARE CONTROL REGISTER
704   0024277E 1480                         MOVE.B   D0,(A2)            TURN DRYER OFF
705   00242780 4E75                         RTS
706
707   00242782 1012               TRANSON   MOVE.B   (A2),D0
708   00242784 00000004                     OR.B     #$04,D0            PREPARE CONTROL REGISTER
709   00242788 1480                         MOVE.B   D0,(A2)            TURN TRANSPORT ON
710   0024278A 4E75                         RTS
711
712   0024278C 020000FB           TRANSOFF  AND.B    #$FB,D0            PREPARE CONTROL REGISTER
713   00242790 1480                         MOVE.B   D0,(A2)            TURN TRANSPORT OFF
714   00242792 4E75                         RTS
715
716   00242794 00030010           TRANSREV  OR.B     #$10,D3            PREPARE CONTROL REGISTER
717   00242798 15430003                     MOVE.B   D3,3(A2)           TURN TRANSPORT ON
718   0024279C 4E75                         RTS
719
720   0024279E 020300EF           TRANSFOR  AND.B    #$EF,D3            PREPARE CONTROL REGISTER
721   002427A2 15430003                     MOVE.B   D3,3(A2)           TURN TRANSPORT OFF
722   002427A6 4E75                         RTS
723
724
725   002427A8 00000001           CHARGON   OR.B     #$01,D0            PREPARE CONTROL REGISTER
726   002427AC 1480                         MOVE.B   D0,(A2)            TURN SCOROTRON ON
727   002427AE 4E75                         RTS
728
729   002427B0 1012               CHARGOFF  MOVE.B   (A2),D0            READ PORT 0
730   002427B2 020000FE                     AND.B    #$FE,D0            PREPARE CONTROL REGISTER
731   002427B6 1480                         MOVE.B   D0,(A2)            TURN SCOROTRON OFF
732   002427B8 4E75                         RTS
733
734   002427BA 00030008           RDYLTON   OR.B     #$08,D3
735   002427BE 15430003                     MOVE.B   D3,3(A2)           WRITE PORT 3
736   002427C2 4E75                         RTS
737
738   002427C4 020300F7           RDYLTOFF  AND.B    #$F7,D3
739   002427C8 15430003                     MOVE.B   D3,3(A2)           WRITE PORT 3
740   002427CC 4E75                         RTS
741
742   002427CE 00000010           TONERON   OR.B     #$10,D0            PREPARE CONTROL REGISTER
743   002427D2 1480                         MOVE.B   D0,(A2)            TURN TONER PUMP ON
744   002427D4 4E75                         RTS
745
746   002427D6 020000EF           TONEROFF  AND.B    #$EF,D0            PREPARE CONTROL REGISTER
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747   002427DA 1480                MOVE.B  D0,(A2)          TURN TONER PUMP OFF
748   002427DC 4E75                RTS
749
750   002427DE 1012          DEVELOFF MOVE.B  (A2),D0
751   002427E0 020000FD            AND.B   #$FD,D0          PREPARE CONTROL REGISTER
752   002427E4 1480                MOVE.B  D0,(A2)          TURN DEVELOPMENT ELECTRODE OFF
753   002427E6 4E75                RTS
754
755   002427E8 00000040      VACUMON OR.B    #$40,D0          PREPARE CONTROL REGISTER (PORT 0,
756                                *                           BIT 6).
757   002427EC 1480                MOVE.B  D0,(A2)          TURN VACUUM ON
758   002427EE 7C14                MOVE.L  #20,D6           1.5 SEC DELAY
759   002427F0 2E3C0000FFFF VI     MOVE.L  #$FFFF,D7        100 MILLISEC DELAY
760   002427F6 51CFFFFE      VACDEL  DBF     D7,VACDEL
761   002427FA 51CEFFF4            DBF     D6,VI
762   002427FE 4E75                RTS
763
764   00242800 020000BF      VACUMOFF AND.B  #$BF,D0          PREPARE CONTROL REGISTER
765   00242804 1480                MOVE.B  D0,(A2)          TURN VACUUM OFF
766   00242806 4E75                RTS
767
768   00242808 00000008      FSHTRON OR.B    #$08,D0          PREPARE CONTROL REGISTER (PORT 0,
769                                *                           BITS 3 AND 7)
770   0024280C 1480                MOVE.B  D0,(A2)          TURN FUSER HEAT ON
771   0024280E 4E75                RTS
772
773   00242810 020000F7      FSHTROFF AND.B  #$F7,D0          PREPARE CONTROL REGISTER
774   00242814 1480                MOVE.B  D0,(A2)          TURN FUSING HEAT OFF
775   00242816 4E75                RTS
776
777   00242818 00000080      FSPEDON OR.B    #$80,D0          PREPARE CONTROL REGISTER (PORT 0,
778                                *                           BITS 3 AND 7)
779   0024281C 1480                MOVE.B  D0,(A2)          TURN FUSER SPEED ON
780   0024281E 4E75                RTS
781
782   00242820 0200007F      FSPEDOFF AND.B  #$7F,D0          PREPARE CONTROL REGISTER
783   00242824 1480                MOVE.B  D0,(A2)          TURN FUSING SPEED OFF
784   00242826 4E75                RTS
785
786   00242828 00030002      AIRPULSE OR.B   #$02,D3          PREPARE CONTROL REGISTER
787   0024282C 15430003            MOVE.B  D3,3(A2)         TURN AIR PULSE ON
788   00242830 7E27                MOVE.L  #39,D7           4.0 SECOND PULSE LENGTH
789   00242832 6100FEC8            BSR     SECOND
790   00242836 020300FD            AND.B   #$FD,D3          PREPARE CONTROL REGISTER
791   0024283A 15430003            MOVE.B  D3,3(A2)         TURN AIR PULSE OFF
792   0024283E 4E75                RTS
793
794   00242840 00030004      BEEP    OR.B    #$04,D3          PREP CONTROL REGISTER
795   00242844 15430003            MOVE.B  D3,3(A2)         TURN ON BEEPER
796   00242848 7E04                MOVE.L  #4,D7            500 MILLISEC BEEP
797   0024284A 6100FEB0            BSR     SECOND
798   0024284E 020300FB            AND.B   #$FB,D3          PREP CONTROL REGISTER
799   00242852 15430003            MOVE.B  D3,3(A2)         TURN OFF BEEPER
800   00242856 4E75                RTS
801
802   00242858 7A04          BEEP5   MOVE.L  #4,D5            5 BEEPS
803   0024285A 7E02          MBEEP   MOVE.L  #2,D7            300 MILLISEC OFF
804   0024285C 6100FE9E            BSR     SECOND
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 805   00242850 61DE              BSR     BEEP
 806   00242852 61CDFFF6          DBF     D5,MBEEP
 807   00242856 4E75              RTS
 808   00242858 162A0003  CAMDOWN MOVE.B  3(A2),D3
 809   0024285C 00030001          OR.B    #$01,D3          PREPARE CONTROL REGISTER
 810   00242870 15430003          MOVE.B  D3,3(A2)         TURN FUSER CAM DOWN
 811   00242874 7E06              MOVE.L  #06,D7           700 MSEC FOR MOTOR TO TURN
 812   00242876 6100FE84          BSR     SECOND
 813   0024287A 020300FE          AND.B   #$FE,D3          PREPARE CONTROL REGISTER
 814   0024287E 15430003          MOVE.B  D3,3(A2)         TURN FUSER CAM MOTOR OFF
 815   00242882 4E75              RTS
 816
 817   00242884 162A0003  CAMUP   MOVE.B  3(A2),D3
 818   00242888 00030001          OR.B    #$01,D3
 819   0024288C 15430003          MOVE.B  D3,3(A2)
 820   00242890 122A0001  CAMLOOP MOVE.B  1(A2),D1         READ INPUT PORT 1
 821   00242894 08010004          BTST    #$04,D1          LOOK FOR HIGH SIGNAL
 822   00242898 66F6              BNE     CAMLOOP          KEEP LOOKING FOR SENSOR
 823   0024289A 020300FE          AND.B   #$FE,D3
 824   0024289E 15430003          MOVE.B  D3,3(A2)
 825   002428A2 4E75              RTS
 826
 827   002428A4 122A0001  FILMSENS MOVE.B  1(A2),D1        READ FILM PRESENCE AT SCOROTRON SENSOR
 828   002428A8 4E75              RTS
 829
 830   002428AA 020200FE  FEEDFILM AND.B   #$FE,D2         SER. COMMUNICATION LINE IS PORT
 831                              *                           2, BIT 0.
 832   002428AE 157C0000FFFF      MOVE.B  #$00,-1(A2)      RECONFIG DDR; SER COMM LINE OUTPUT
 833   002428B4 15420002          MOVE.B  D2,2(A2)         FILM FEED SIGNAL
 834   002428B8 2E3C00003F88      MOVE.L  #$3F88,D7        20 MSEC PULSE LENGTH
 835   002428BE 51CFFFFE  FFLP    DBF     D7,FFLP
 836   002428C2 00020001          OR.B    #$01,D2          TURN OFF SIGNAL
 837   002428C6 15420002          MOVE.B  D2,2(A2)
 838   002428CA 157C0009FFFF      MOVE.B  #$09,-1(A2)      RECONFIG DDR; SER COMM LINE IS INPUT
 839   002428D0 7E13      HOLDLOOP MOVE.L  #19,D7           WAIT 2. SEC BEFORE LOOKING FOR
 840   002428D2 6100FE28          BSR     SECOND           HANDSHAKE
 841   002428D6 4287              CLR.L   D7               PREP D7 FOR HANDSHAKE LOOP COUNTER
 842   002428D8 142A0002  HANSHK  MOVE.B  2(A2),D2          READ PORT 2
 843   002428DC 5287              ADDQ.L  #1,D7
 844   002428DE 0C87000A0000      CMPI.L  #$A0000,D7       APPROX 6 SECOND WAIT IN LOOP
 845   002428E4 67000028          BEQ     ERRFF
 846   002428E8 08020000          BTST    #$00,D2
 847   002428EC 66EA              BNE     HANSHK           LOOP IF HANDSHAKE SIGNAL IS STILL HIGH
 848   002428EE 2E3C00004000      MOVE.L  #$4000,D7        CHECK TO BE SURE NOT STILL LOW AFTER
 849   002428F4 51CFFFFE  CHECK   DBF     D7,CHECK         10 MSEC
 850   002428F8 142A0002          MOVE.B  2(A2),D2
 851   002428FC 08020000          BTST    #$00,D2
 852   00242900 67CE              BEQ     HOLDLOOP         KEEP LOOKING FOR HANDSHAKE IF STILL  W
 853   00242902 3E3C0015          MOVE.W  #$15,D7
 854   00242906 6100FDF4          BSR     SECOND
 855   0024290A 6000001C          BRA     NORM
 856   0024290E 6100FF48  ERRFF   BSR     BEEP5            FIVE BEEPS
 857   00242912 4BFAFA75          LEA     FFE1(PC),A5      FILM FEED ERROR MESSAGE
 858   00242916 4DFAFA93          LEA     FFE2(PC),A6
 859   0024291A 4E4F              TRAP    #15
 860   0024291C 0006              DC.W    OUTPUT
 861   0024291E 11FC000023AB      MOVE.B  #0,PASS          CLEAR PASS COUNTER LOCATION
 862   00242924 6000F71A          BRA     RESTART
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  863   00242928 4E75          NORM     RTS
  864
  865   0024292A 08050000      COUNTER  BTST     #0,D5              LOOKING FOR BLACK OR WHITE?
  866   0024292E 66000028               BNE      WHTCNT1
  867   00242932 122A0001               MOVE.B   1(A2),D1           READ PORT 1
  868   00242936 08010002               BTST     #2,D1              LOOK FOR BLACK(=1)
  869   0024293A 67000048               BEQ      TEST               TRY AGAIN IF NOT BLACK
  870   0024293E 02020001               AND.B    #$01,D2            FLAG THAT ONE BLACK HAS BEEN SEEN
  871   00242942 08020000               BTST     #0,D2              LOOK TO SEE IF 1 BLACK ALREADY SEEN
  872   00242946 67000036               BEQ      ADDONE             COUNT 1 BLACK IF NONE PREVIOUSLY
  873   0024294A 02020000               AND.B    #$00,D2            REMOVE FLAG WHEN 1 BLACK ALREADY SEEN
  874   0024294E 00050001               OR.B     #$01,D5            FLAG THAT 2 BLACKS SEEN--READY TO
  875                         *                                     COUNT WHITES
  876   00242952 51CFFFD6               DBF      D7,COUNTER         SUBTRACT 1 FROM THE NUMBER OF
  877                         *                                     TRANSITIONS EXPECTED
  878   00242956 4E75                   RTS
  879
  880   00242958 122A0001      WHTCNT1  MOVE.B   1(A2),D1           READ PORT 1
  881   0024295C 08010002               BTST     #2,D1              LOOK FOR WHITE(=0)
  882   00242960 66000022               BNE      TEST
  883   00242964 02020001               AND.B    #$01,D2            IF WHITE,SET FLAG THAT 1 WHITE
  884                         *                                     HAS BEEN SEEN
  885   00242968 08020000               BTST     #0,D2              LOOK TO SEE IF THIS IS THE FIRST
  886                         *                                     OR SECOND WHITE
  887   0024296C 67000010               BEQ      ADDONE             ADD 1 TO D2 IF THIS IS THE FIRST
  888   00242970 02020000               AND.B    #$00,D2            REMOVE FLAG IF THIS IS THE SECOND
  889   00242974 02050000               AND.B    #$00,D5            ZERO FLAG TO LOOK FOR BLACK
  890   00242978 51CFFFB0               DBF      D7,COUNTER         SUBTACT 1 FROM THE # OF EXPECTED
  891                         *                                     TRANSITIONS
  892   0024297C 4E75                   RTS
  893
  894   0024297E 00020001      ADDONE   OR.B     #$01,D2            ADD 1 TO FLAG THAT 1 OF A NEW COLOR
  895                         *                                     HAS BEEN SEEN
  896   00242982 60A6                   BRA      COUNTER
  897   00242984 08020000      TEST     BTST     #0,D2              TEST TO SEE IF 1 OF THE DESIRED
  898                         *                                     COLOR HAS ALREADY BEEN SEEN
  899   00242988 67A0                   BEQ      COUNTER            IF IT ISN'T, REPEAT
  900   0024298A 02020000               AND.B    #$00,D2            IF IT IS, REMOVE IT
  901   0024298E 609A                   BRA      COUNTER
  902
  903   00242990 41FAF66E      COPYCODE LEA      START(PC),A0
  904   00242994 43FAFFFA               LEA      COPYCODE(PC),A1
  905   00242998 247C00002000           MOVE.L   #$2000,A2          RELOCATE PROGRAM TO $2000
  906   0024299E 24D8          COPYLOOP MOVE.L   (A0)+,(A2)+
  907   002429A0 B3C8                   CMPA.L   A0,A1
  908   002429A2 62FA                   BHI      COPYLOOP
  909   002429A4 700F                   MOVE.L   #15,D0             EXIT TO DOS
  910   002429A5 4E41                   TRAP     #1
  911
  912             00242990              END      COPYCODE

****** TOTAL ERRORS      0--
****** TOTAL WARNINGS    0--
```

SYMBOL TABLE LISTING

SYMBOL NAME	SECT	VALUE	SYMBOL NAME	SECT	VALUE
ADDONE		0024297E	HOMESENS		00242740
AIRPULSE		00242820	HRETRACE		00000002
BCS		00000020	IMAG1BAS		00300000
BEAMOFF		FFFFFFFF	IMAG2BAS		00580000
BEEP		00242840	IMAGBASE		002423AC
BEEP5		00242858	IMAGE		002423E0
BLANKCRT		00242530	IMAGE1		0024240E
BLANKLIN		0050B9F8	IMAGE2		00242424
BM		00000028	IMAGE3		00242438
CAMDOWN		00242868	IMAGEMEM		000023AC
CAMLOOP		00242890	IMG_IN1		0024256E
CAMUP		00242884	IMG_IN2		00242584
CHAN0		00000000	IMG_INIT		0024254C
CHAN1		00000040	INTSERV		00242470
CHARGOFF		002427B0	INTSVCA		00242488
CHARGON		002427A8	LL		00000494
CHECK		002428F4	LM		00000047
CLRPORT		00242752	LOFFSET		0000000A
CONG		0024235C	LUTBASE		00FF0A00
CONG2		00242389	LUT_INI		002425E8
CONTINU		0024244A	LUT_INI		0024253E
COPYCODE		00242990	MEEEP		002428EA
COPYLOOP		0024293E	NEXTEXIT		00242AF8
COUNTER		0024292A	NEXTLINE		00242AD4
CRTY_C		00FF0904	NEXTREP		00242AEA
CS		00000004	NLEND		0024251C
DEVELOFF		002427DE	NLMID		00242506
DEVELON		00242AE0	NLSAVE		00242526
DMABASE		00FF0800	NORM		00242928
DMABFC		00000039	NWRITES		00000002
DMACCR		00000097	NXTLINIT		0024249A
DMACLR		0024287A	OUTPUT		00000006
DMACLRI		00242898	PAS1		002423A8
DMACPR		0000002D	PASS		000023AB
DMACSR		00000000	PL		00000726
DMADAR		00000014	PIXHIGH		00000015
DMAOCR		00000004	PIXLOFF		00000000
DMADFC		00000031	PIXLOW		00000011
DMAEIN		00000027	RC		00000001
DMAGCR		000000FF	RDYLTOFF		002427C4
DMAINI		002425D2	RDYLTON		002427BA
DMAIN2		002425D8	READ1		0024271C
DMAMAR		0000000C	READ2		00242730
DMAMFC		00000029	READGO		0024270C
DMAMTC		0000000A	RERESTRT		00242936
DMANIN		00000025	RESTART		00242040
DMAOCR		00000005	RM		00000047
DMASCR		00000006	SI		00242702
DMA_INI		002425C0	SECOND		00242EFC
DUSEBASE		00240000	SPASS1		00242319
DRYEROFF		0024277A	SPASS2		00242338
DRYERON		00242772	START		00242000

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ERRFF	0024290E	STPPXC	0000FFD0
FEEDFILM	002428AA	STR1	002422C0
FFE1	00242389	STR2	002422E7
FFE2	002423AB	STRPXC	0000FF70
FFLP	002428EE	TCS	00000028
FFSA1	002422E7	TEST	00242934
FFSA2	002422FB	TM	0000010E
FGSERV	00242678	TMRCTL	00FF0902
FILMPASS	0024214E	TMRDAT	00FF0900
FILMSENS	002428A4	TMR_INI	00242694
FL	000001E0	TONEROFF	002427D6
FPASS1	002422FB	TONERON	002427CE
FPASS2	00242319	TRANSFOR	0024279E
FSHTROFF	00242810	TRANSOFF	0024278C
FSHTRON	00242808	TRANSON	00242782
FSPEDOFF	00242820	TRANSREV	00242794
FSPEDON	00242818	V1	002427F0
GOB1	0024235A	VACDEL	002427F6
GOB2	0024236C	VACUMOFF	00242800
H1	00242248	VACUMON	002427E8
H2	00242281	WGB1	00242338
HANSHK	002428D8	WGB2	0024235A
HOLDLOOP	002428D0	WHTCNT1	00242958
HOM1	00242231	YTABLE	0024254A
HOM2	002422C0	ZLUT	0000A000
HOMESEE	00242746	ZSEL	00FF0908

```
 1                          *       STEPWDG1            7/15/86   KB,MAH,AS
 2                          *
 3                          *       PROGRAM TO PLACE IN THE FIRST IMAGE MEMORY A
 4                          *       STEP WEDGE ON AN 1172 PIXEL PER LINE MULTI-FORMATTED IMAGE
 5                          *
 6          00000470        WRAP    EQU     1136                FROM END OF STEP WEDGE TO
 7                          *                                   START OF STEP WEDGE ON NEXT LINE
 8          00300000        IMGBASE EQU     $300000             FIRST IMAGE MEMORY BASE ADR
 9          00333C5B        STARTADR EQU    IMGBASE+(100*1172)+71+512+4+512
10
11          00242000                ORG     $242000
12  00242000 41F900333C5B   START   LEA.L   STARTADR,A0          START OF IMAGE AREA
13  00242006 4281                   CLR.L   D1
14  00242008 760E                   MOVE.L  #14,D3              15 STEP WEDGES
15  0024200A 7468           PICTURE MOVE.L  #104,D2             105 LINES PER WEDGE
16  0024200C 7023           BLOCK   MOVE.L  #35,D0              36 PIXELS PER WEDGE WIDTH
17  0024200E 10C1           LOOP    MOVE.B  D1,(A0)+            WRITE PIXEL
18  00242010 51C9FFFC               DBF     D0,LOOP
19  00242014 D1FC00000470           ADDA.L  #WRAP,A0            INCREMENT TO NEXT LINE AT WEDGE START
20  0024201A 51CAFFF0               DBF     D2,BLOCK
21  0024201E 06010012               ADD.B   #18,D1              INCREMENT PIXEL INTENSITY
22  00242022 51CBFFE6               DBF     D3,PICTURE
23                          *
24  00242026 700F                   MOVE.L  #15,D0              EXIT TO VERSADOS
25  00242028 4E41                   TRAP    #1
26                          *
27          00242000                END     START

****** TOTAL ERRORS    0
****** TOTAL WARNINGS  0
```

STEP WEDGE GENERATOR 72

```
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SYMBOL TABLE LISTING

SYMBOL NAME     SECT   VALUE      SYMBOL NAME     SECT   VALUE

BLOCK                  0024200C   START                  00242000
IMGBASE                00300000   STARTADR               00333C5B
LOOP                   0024200E   WRAP                   00000470
PICTURE                0024200A
```

LISTING FOR IMPLEMENTATION OF

LOOK-UP TABLE GENERATOR 66

```
/* DOLUT.CC  -  Manages look-up table data & files */
/* K.P Golden, Electronic Imaging, DuPont Company  */
/*                                                 */
/* When values are modified, 15 measurements are   */
/* expected to be supplied.  These are optical     */
/* densities measured in target areas imaged with  */
/* 8-bit values of 0,18,36 ... 252 (spaced by 18)  */
/*                                                 */
/* LUT data is loaded into RAM for later use       */

#include <MATH.HH>

#define ROMODE 0                        /* file-system arguments */
#define WOMODE 1
#define RUMODE 2

#define ZLUT 0xA000         /* ram image of LUT */
unsigned int *lutptr;

#define BLEN 80
char buf[BLEN+1],*bufptr;               /* working line buffer */
static char prefix[22] = ("        DC.W      \0$0");

int margc;                              /* global versions of mains's */
char *margv[10];

main(argc,argv)
int argc;
char *argv[];
{
/********* D E C L A R A T I O N S *********/
char filename[32],*fnamep;              /* composite file name string */
int fileds;                             /* main file descriptor */
int bfileds;                            /* backup file descriptor */
char backname[32],*bnamep;              /* backup file name string */
int status;                             /* used with "file" calls */
int i,j,k;                              /* general indexes */
long int olut[256],nlut[256];           /* look-up values */

/********* S I G N O N **********/
printf("\033[0mLook-up table manager, K.P Golden, 10/16/86\n" );
if( argc < 2 )
  {
  printf( "syntax = DOLUT <filename> [-M]\n" );
  printf( "If -M absent:  <filename> LT is read into RAM at $%-x\n",ZLUT );
  printf( "If -M present: <filename> LT replaces <filename>.BK   This\n" );
  printf( "               data is updated per supplied O.D. measurements,\n" );
  printf( "               & loaded into RAM, replacing <filename> LT\n" );
  printf "optional 3rd argument:  -L forces linear table\n" );
  printf( "                   or:  -X supplies O.D. values automatically\n" );
  exit( 0 );
  }
margc = argc;           /* publish arguments for subroutines */
for( i=0; i<argc; i++ )
  margv[i] = argv[i];

/********** S E T U P   F I L E N A M E S **********/
bufptr = argv[1];       /* get filename from 1st argument */
fnamep = &filename[0];
bnamep = &backname[0];
while( *bufptr <= ' ' )
  bufptr++;             /* parse past leading space */
while( *bufptr > ' ' )
```

```
  {
  if( *bufptr >= 'a' )
    *bufptr -= 32;          /* capitalize if necessary */
  *fnamep++ = *bufptr;      /* collect filename chars */
  *bnamep++ = *bufptr++;    /* while parsing past filename */
  }
/* complete filename strings */
*(fnamep++) = *(bnamep++)       = '.';
*(fnamep++) = 'L';  *(bnamep++) = 'B';
*(fnamep++) = 'T';  *(bnamep++) = 'K';
*fnamep     = *bnamep           = '\0';

/******* R E A D   L U T   F I L E ********/
if((fileds = open(filename,ROMODE)) < 0)
  {
  sherr( "opening",filename,fileds );
  printf( "Want to create file: %s with a linear table (y)?\n", filename );
  scanf( "%s",buf );
  if( (buf[0]!='y') && (buf[0]!='Y') )
    exit(0);
  if((fileds = creat(filename,RWMODE)) < 0)
    errq( "creating",filename,fileds );
  else
    {
    for( i=0; i<256; i++ )          /* force linear table */
      olut[i] = (long int)(65535)-(long int)(i)*(long int)(257);
    putlut( fileds,olut );
    }
  }
else
  getlut( fileds,olut );   /* fetch a look up table */
if((status = close(fileds)) < 0)
  sherr( "closing",filename,status );
for( i=0; i<256; i++ )
  nlut[i] = olut[i];          /* initially new == old */

/******* D E T E R M I N E   I F   M O D I F Y ********/
bufptr = argv[2];
if( (argc >= 3) &&                                  /* 2nd argument */
    (bufptr[0] == '-') &&                           /* starts "-" */
    ( (bufptr[1] == 'm') || (bufptr[1] == 'M') )    ) /* is "m" or "M" */
  {
  /******* B A C K U P   L U T   F I L E ********/
  if((fileds = open(filename,ROMODE)) < 0)
    errq( "opening",filename,fileds );
  if((bfileds = creat(backname,WOMODE)) < 0)
    errq( "opening",backname,bfileds );
  for( i=0; i<32; i++ )     /* copy to name.bk */
    if((j=read(fileds,buf,BLEN)) <= 0)
      errq( "reading",filename,j );
    else
      if((status=write(bfileds,buf,j)) != j)
        errq( "writing",backname,status);
  if((status = close(fileds)) < 0)
    sherr( "closing",filename,status );
  if((status = close(bfileds)) < 0)
    errq( "closing",backname,status );

  /******* R E V I S E   L U T   D A T A ********/
  bufptr = argv[3];
  if( (argc >= 4) &&                    /* 3nd argument */
      (bufptr[0] == '-') &&             /* starts "-" */
      ( (bufptr[1] == 'l') || (bufptr[1] == 'L') ) /* is "L" */
    for( i=0; i<256; i++ )              /* force linear table */
      nlut[i] = (long int)(65535)-(long int)(i)*(long int)(257);
  else                                  /* else interactive mode */
```

```
    ...(olut,nlut );

  /******* W R I T E   L U T   F I L E *******/
  if( (fileds = creat(filename,UNKNOWN)) < 0 )
    error( "creating",filename,status );
  putlut( fileds,nlut );
  if(status = close(fileds)) < 0)
    error( "closing",filename,status );
  }

/******* L O A D   L U T   I N T O   R A M *******/
lutptr = (unsigned long int)ZLUT;  /* absolute adrs */
for( i=0; i<256; i++ )
  *(lutptr++) = (unsigned int)nlut[i];

/******** E X H I B I T   L U T   D A T A ********/
printf( "\015\012\n" );
printf( "Look-up table loaded at %x contains:\n", ZLUT );
lutptr = (unsigned long int)ZLUT;  /* absolute adrs */
for( i=0; i<32; i++ )              /* show 32 lines */
  {
  for( j=0; j<8; j++ )             /* of 8 numbers each */
    {
    if( j != 0 )
      printf( "," );               /* exhibition separator char */
    printf( "%5u", *(lutptr++) );  /* exhibit value */
    }
  printf( "\015\012\n" );          /* terminate exhibit line */
  }

exit(0);
}

/* Algorithm for revising the LUT data is after the example provided */
/* by the program MISLUT.CC written by M. Momcilovich, mid 1986      */
revlut( oldlut,newlut )
long int *oldlut,*newlut;
{
        int i,j,k;                      /* general purpose indexes */
        float fnewlut[15];              /* float versions of LUT */
        float od[15];                   /* user supplied O.D. readings */
        int lower,upper;                /* indexes for min & max unbound */
        float odtarg;                   /* computed target O.D. value */
        float slope;                    /* deltaLUT per deltaOD */

        printf( "\015\012\n" );
        printf ("Enter new Optical Density readings in descending order\n");
        printf (" for 15 areas imaged with 8-bit values starting with\n" );
        printf (" 252 ($FC) and decending to 0 by steps of 18 ($12) \n" );
        printf ("There must be at least .02 separation in readings.\n");
        printf ("Hit return after each entry \n");
        bufptr = margv[3];
        if( (margc >= 4) &&                 /* 3nd argument */
            (bufptr[0] == '-') &&           /* starts "-" */
            ( (bufptr[1] == 'x') || (bufptr[1] == 'X') ) ) /* is "x" */
          for( i=0; i<15; i++ )
            {
            od[i] = 3.1 - 0.2 * (float)i;
            printf( "Using O.D. for level %5-2d = %f\n", i+1, od[i]);
            }
        else
          for( i=0; i<15; i++)
            do
            {
            printf( "O.D. for level %5-2d = ?\n", i+1 );
            j = scanf( "%s",buf );
```

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```
      val[j] = (float)atof( buf );
      }
    while( (od[i]<=0.0) || (od[i]>6.0) || (j<=0) );

  /* compute floating values for LUT at input O.D. points */
  /* point #1 is a special case */
  lower = 0;
  for( i=0; (i<15) && (od[i+1]==od[i]); i++)
    {
    lower  = 18*(i+1);   /* assign lower = lowest unbounded */
    }
  fnwlut[0] = (float)oldlut[lower];

  /* compute points #2 ... #14 */
  for (i=1; i<14; i++)  /* work down from next highest O.D. */
    {
    /* compute target O.D. value if linearized */
    odtarg = (float)( (double)od[0] -
             (double)i * ((double)od[0] - (double)od[14])/
                         (double)14.0
               + (double)0.000)                        );
             /* use slightly larger value to resolve ambiguity */
             /* which occurs when O.D. values are equally spaced */
    j = 0;
    while( (od[j] > odtarg) && (j<14) )
      j++;
    k = 18*(--j);    /* leaves j as index of O.D. input */
                     /* which is larger than "odtarg" */
                     /* but smallest of those available */

    slope = (float)( (oldlut[k+18] - oldlut[k]) /
                     (od[j+1]      - od[j]     )    );
    fnwlut[i] = (float)oldlut[k] + slope*(odtarg - od[j]);

//  printf( "#%-2d  target=%6f base#=%-2d rate=%6f\n",
//           i+1,   odtarg,     j+1,      slope            );
    }

  /* finally compute point #15 as a special case too */
  upper = 252;
  for( i=14; ((i>=0) && (i != (lower/18+1))) ; i--)
    {
    if( od[i-1]==od[i] )
      upper = 18*(i-1);  /* assign upper = highest unbounded */
    }
  fnwlut[14] = (float)oldlut[upper];

  /* exhibit values computed for new LUT at O.D. input points */
//for( i=0; i<15; i++ )
//  printf( "Fnwlut(%-2d) = %6f\n", i,fnwlut[i] );

  /* interpolate actual integer LUT values at all points */
  for( i=0; i<14; i++ )
    {
    for( j=0; j<18; j++ )
      newlut[ 18*i+j ] = (long int)(    fnwlut[i] +
                  (float)j*(fnwlut[i+1] - fnwlut[i])/
                                 18.00           );
    }
  /* there are 15 steps of 18 counts to establish 0...255 range */
  /* but this ends just before $FC = 252.  Manually enter the rest */
  newlut[252] = (long int)( fnwlut[14]                          );
  newlut[253] = (long int)( fnwlut[14] + (fnwlut[14]-fnwlut[13])/18.0 );
  newlut[254] = (long int)( fnwlut[14] + (fnwlut[14]-fnwlut[13])/9.00 );
  newlut[255] = (long int)( fnwlut[14] + (fnwlut[14]-fnwlut[13])/6.00 );
```

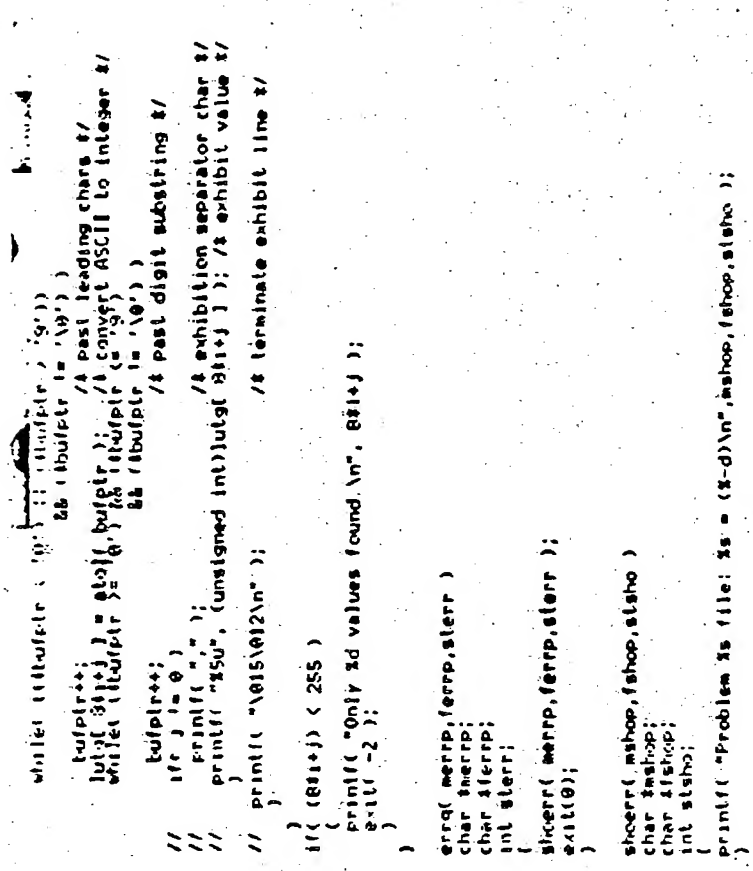
```
        for( i=0; i<256; i++ )          /* if float calculation went here */
          {                             /* force actual integer to zero */
          if( newlut[i]   (long int)0     )
            newlut[i] = (long int)0;
          if( newlut[i] > (long int)0xFFFF )
            newlut[i] = (long int)0xFFFF;
          }
}

putlut( fdp,lutp )
int fdp;
long int lutp[];
{
auto int i,j;                   /* general purpose indexes */
auto int status;                /* system-call return variable */

for( i=0; i<32; i++)            /* do 32 lines of output */
  {
  for( j=0; j<BLEN; j++ )
    buf[j] = ' ';               /* pre fill the buffer area */
  strcpy( buf,prefix );         /* attach prefix */
  bufptr = buf + strlen( prefix );
  for( j=0; j<8; j++ )          /* 8 values on each line */
    {
    ltoa( lutp[ 8*i+j ], bufptr, 6 );     /* bug in ltoa needs "6" */
    /* instead of "5" as width   uses more rite space if needed    */
    bufptr += 5;
    *bufptr++ = ',';                      /* followed by comma */
    }
  *( --bufptr ) = '\015';               /* terminate line with CR */
  *( ++bufptr ) = '\012';               /*                 then LF */
  buf[BLEN] = '\0';                     /* terminate string       */
//   printf( "%s",buf );                  /* exhibit the string */
  /* write string out the file */
  if( BLEN != write( fdp, buf, BLEN ) )
    {
    printf( "Problem writing result file= %-d\n",status );
    exit( 0 );
    }
  }
}

getlut( fdg,lutg )
int fdg;
long int lutg[];
{
auto int i,j;                   /* general purpose indexes */
auto int status;                /* system-call return variable */

for( i=0; i<32; i++ )         /* read 32 lines of 8 values */
  {
  for( j=0; j<BLEN; j++ )             /* null working buffer */
    buf[j] = '\0';
  if((status = read(fdg,&buf[0],BLEN)) <= 47)   /* read a line */
    {  /* need at least 8*5+7(commas) characters */
    printf( "Problem reading input file= %-d\n",status );
    printf( "%s\n",buf );
    exit( 0 );
    }
  else
    /* discard the balance of the "record" line */
    {
    buf[BLEN] = '\0';             /* make certain it is terminated */
    bufptr = &buf[0];                     /* initialize pointer */
    for( j=0; j<8; j++ )                    /* for 8 substrings */
      {
```



Claims

1. A method for generating a dynamically corrected look-up table for modulating the intensity of actinic radiation incident on an imaging element comprising the steps of:

(a) modulating the intensity of actinic radiation representative of an image having a predetermined number of variable optical density levels in accordance with a dynamically corrected look-up table;

(b) exposing an imaging element to the modulation actinic radiation representative of the image;

(c) modulating the intensity of the actinic radiation with information representative of a step wedge having a predetermined number of known optical denstiy levels using the dynamically corrected look-up table;

(d) exposing the imaging element to the actinic radiation modulated by the step wedge information;

(e) developing the image and step wedge on the imaging element;

(f) comparing the optical density levels of the developed step wedge to the known optical density levels;

(g) generating a correction signal based on the difference between the developed step wedge optical denstiy and the known optical density levels, and

(h) correcting the look-up table in accordance with the correction signal.

2. The method of claim 1 wherein steps (a) and (c) are performed simultaneously.

3. An exposure control system comprising:

means for storing a look-up table of exposure correction factors;

means for measuring at the actual optical density of an image of a step wedge and generating a signal representative thereof;

means for comparing the signal representative of the step wedge with a known set of optical density levels corresponding to the step wedge to generate a set of correction values; and

means to apply the set of correction values to modify the look-up table of exposure correction factors thereby to form a dynamically corrected look-up table of such exposure correction factors useful to control the intensity of actinic radiation incident on an imaging element.

4. An apparatus for producing a continuous tone toned electrophotographic image comprising:

(a) means for transporting an imaging element along a predetermined path including first and second spaced positions;

(b) a dispenser of imaging elements placed adjacent the transporting means surface to dispense one imaging element at a time from the dispenser onto the transporting means, the imaging element having an imaging surface thereon;

(c) charging means located adjacent to the transporting means following the dispenser in the direction of motion of the tranporting means for establishing a uniform electrical charge on the surface of the imaging element;

(d) means for producing a latent electrostatic image on the imaging surface;

(e) toning means to apply an electrostatic toner on the latent electrostatic image on the imaging surface to render the latent image visible; and

(f) means to permanently fix the toned image;

(g) wherein the means for producing the latent electrostatic image itself comprises:

means for storing a look-up table of exposure correction factors;

means for measuring at the actual optical density of an image of a step wedge and generating a signal representative thereof;

means for comparing the signal representative of the step wedge with a known set of optical density levels corrresponding to the step wedge to generate a set of correction values;

means to apply the set of correction values to modify the look-up table of exposure correction factors thereby to form a dynamically corrected look-up table of such exposure correction factors useful to control the intensity of actinic radiation incident on an imaging element.

FIG. 1

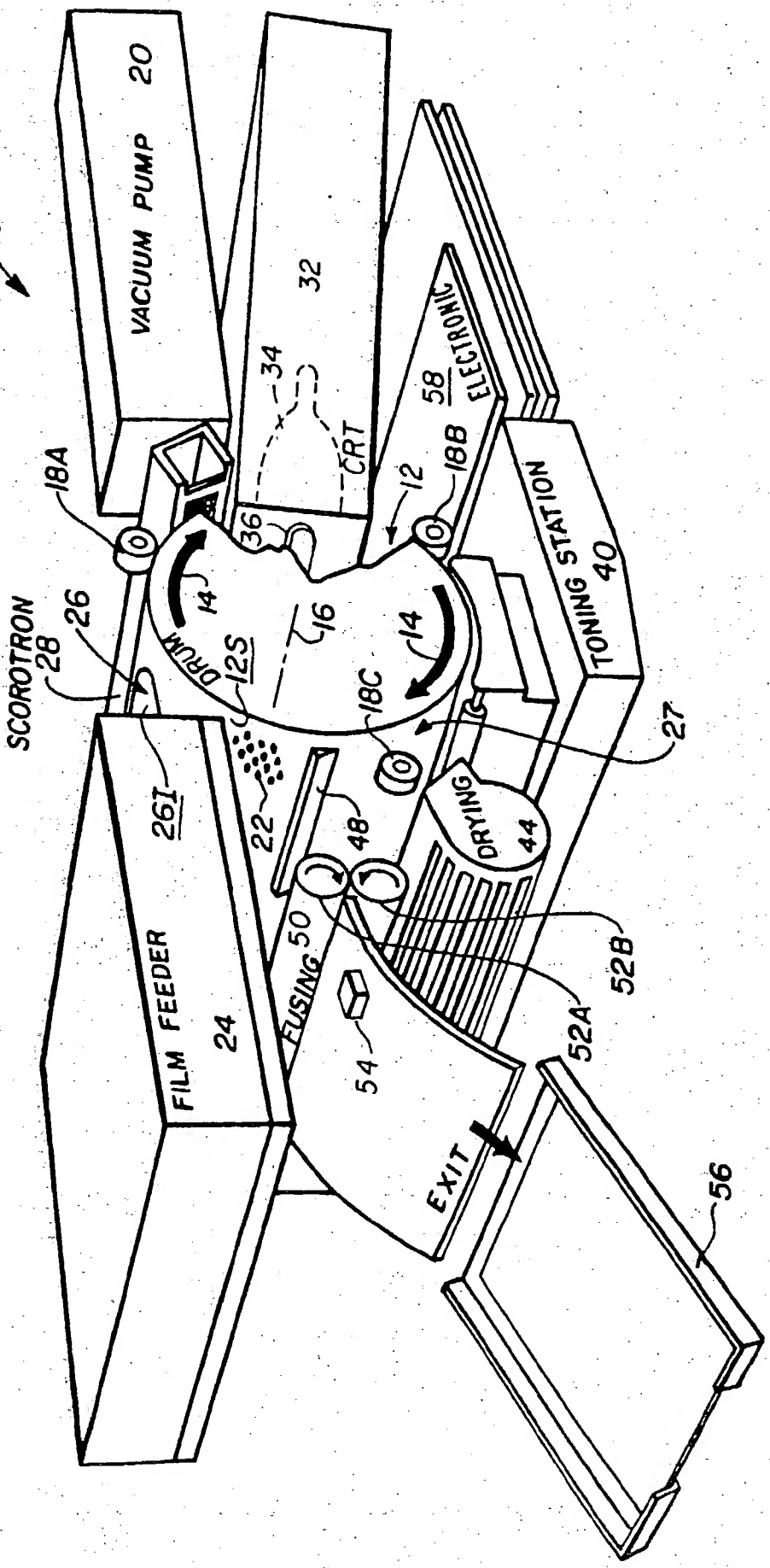


FIG. 2

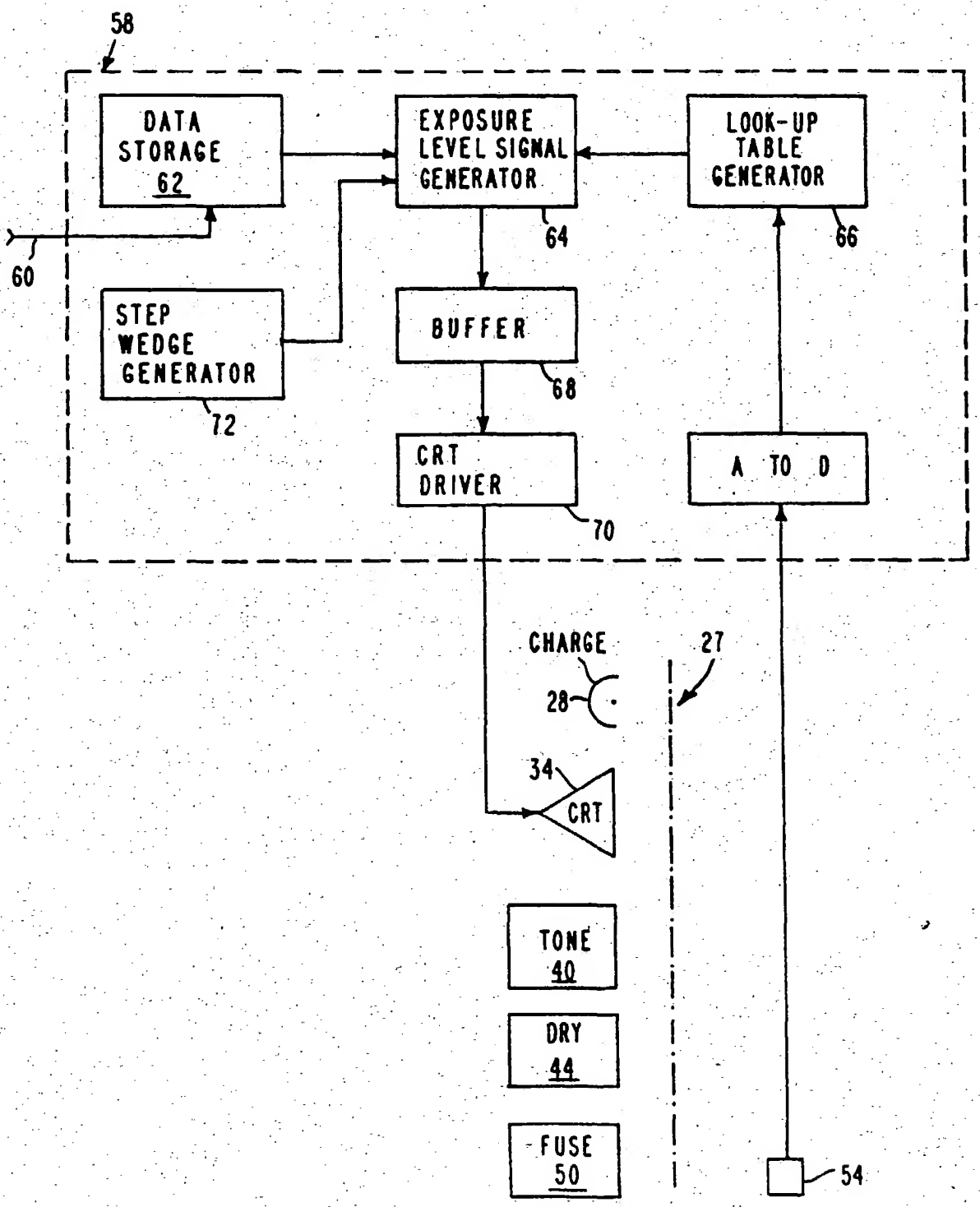

58
DATA STORAGE 62
EXPOSURE LEVEL SIGNAL GENERATOR
LOOK-UP TABLE GENERATOR
64
66
60
STEP WEDGE GENERATOR
72
BUFFER
68
CRT DRIVER
70
A TO D
CHARGE
28
27
34
CRT
TONE 40
DRY 44
FUSE 50
54

FIG. 3

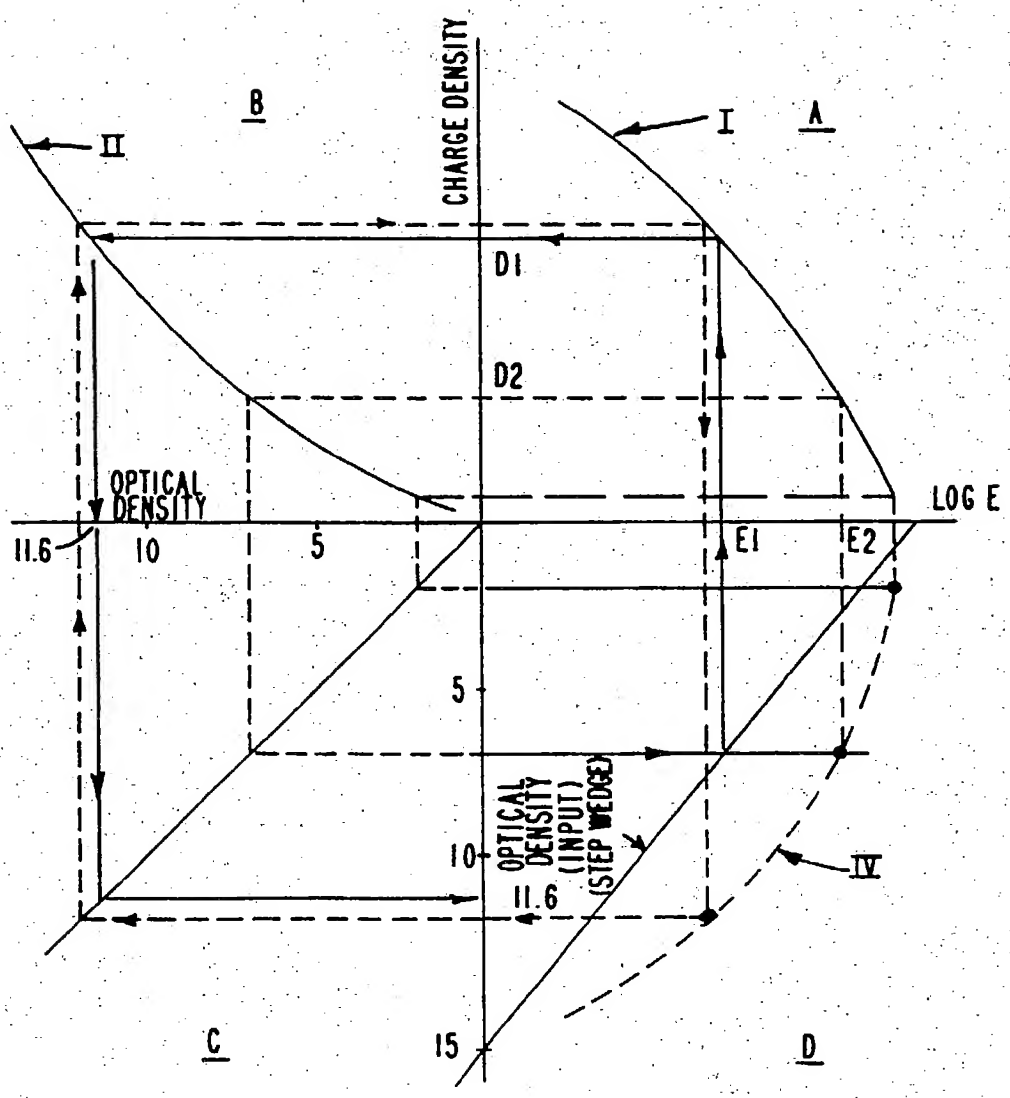
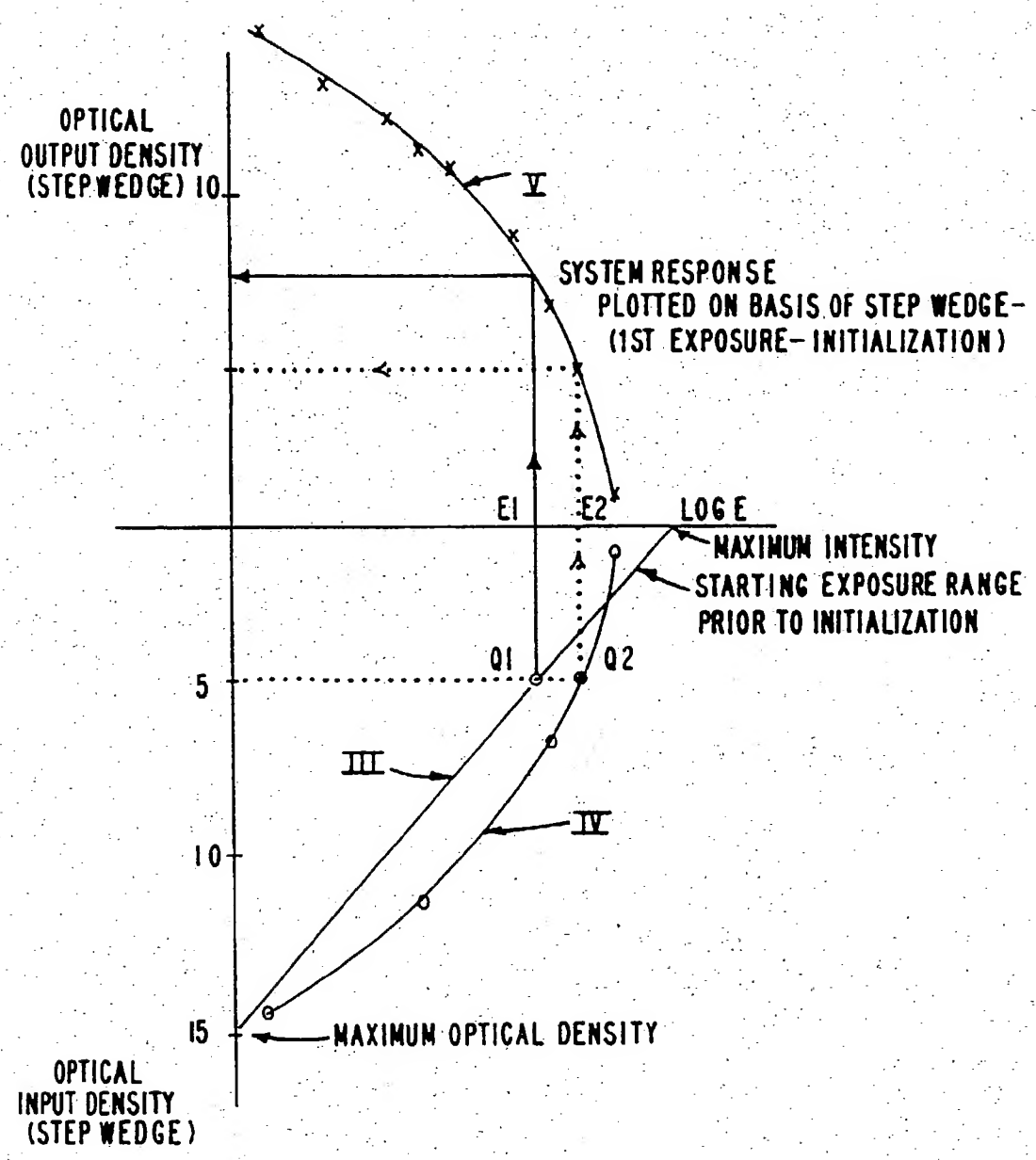


FIG. 4


OPTICAL
OUTPUT DENSITY
(STEP WEDGE) 10
V
SYSTEM RESPONSE
PLOTTED ON BASIS OF STEP WEDGE-
(1ST EXPOSURE- INITIALIZATION)
E1
E2
LOG E
MAXIMUM INTENSITY
STARTING EXPOSURE RANGE
PRIOR TO INITIALIZATION
Q1
Q2
5
III
IV
10
15
MAXIMUM OPTICAL DENSITY
OPTICAL
INPUT DENSITY
(STEP WEDGE)

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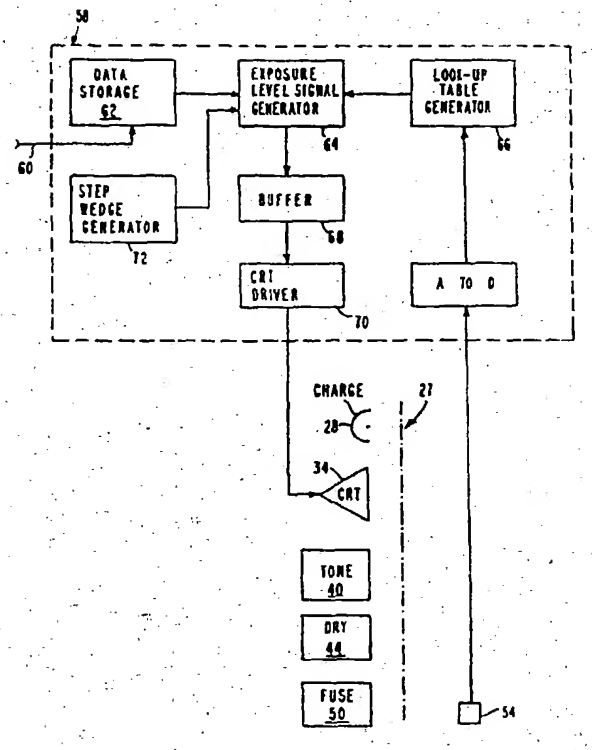
(54) **Explosure control system for continuous tone elektrophotographic film.**

(57) An exposure control system which permits accurate reproduction of optical density levels on a final image is characterized by a dynamically corrected look-up table. The look-up table is used to calculate each desired exposure intensity level for each image pixel on the basis of data obtained during the exposure and development of an immediately preceding image.

F I G. 2



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EUROPEAN SEARCH REPORT

Application Number

EP 87 11 7179

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	GB-A-1 559 341 (XEROX) * complete document *	1-4	G 03 G 15/052 G 03 B 27/72
A	DE-A-3 432 515 (CANON) * complete document *	1-4	
A	EP-A-0 139 174 (MITA INDUSTRIAL) * complete document *	1-4	
A	DE-A-3 605 320 (CANON) * complete document *	1-4	
A	PATENT ABSTRACTS OF JAPAN, vol. 9, no. 86 (P-349)(1809), 16th April 1985; & JP - A - 59 216 165 (CANON) 06-12-1984	1-4	
A	PATENT ABSTRACTS OF JAPAN, vol. 9, no. 161 (P-370)(1884), 5th July 1985; & JP - A - 60 35757_(RICOH) 23.2.1985	1-4	
A	DE-A-3 010 945 (LOG ETRONICS)		TECHNICAL FIELDS SEARCHED (Int. Cl.4)
D,A	THOMES "SPSE Handbook of photographic science and engineering", 1973, Willey Interscience; * pages 783-784 *		G 03 B 27/00 G 03 G 15/00 G 06 K 15/12 H 04 N 1/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	16-10-1988	HOPPE H

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